AN EXPLORATORY INVESTIGATION OF THE ORAL HEALTH OF HOSPITALISED OLDER PEOPLE

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This dissertation is submitted for the degree of Doctor of Philosophy

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For Scott, Terence and William

'Help the aged

'Cause one day you'll be older too'

Pulp, 1998

Declaration

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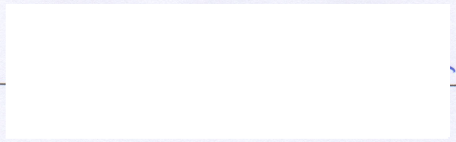
Signed: 

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Abstract

The poor oral health of older people in Australia was well documented 20 years ago in the premier ageing oral health study, The Adelaide Study of Nursing Homes, published in 1999. Since then this study has been replicated across Australia with similar conclusions, the oral health status of older people living in residential care is poor. Access to fluoride and improvements in preventive dentistry have resulted in natural tooth retention and a decrease in the number of fully edentulous older people. Coupled with increased life expectancy and medical complexity there is recognition that this change in dentition status has the potential to impact systemic health. Poor oral health usually results from inadequate daily oral hygiene and leads to a heavy bacterial plaque load that increases the risk of periodontal infection, dental caries as well as aspiration pneumonia.

Older people are often late dental attenders presenting only when symptomatic, and with significant barriers preventing them gaining access to dental care, both physical and financial. In this thesis I highlight the poor oral health status of older people from community and aged-care domiciles admitted to an acute care tertiary hospital, The Queen Elizabeth Hospital (TQEH), in Adelaide, South Australia and make recommendations to improve access to dental care through an acute hospital admission.

The majority of participants in this study had a potential source of infection in their mouths. Dental decay, periodontal disease and oral mucosal conditions were common. Three-quarters of the participants were considered in need of a comprehensive dental consult. Dentate (with teeth) and edentulous (without teeth) participants were just as likely to have dental conditions that required referral to the dentist.

Attempts were made to identify general and medical conditions associated with poor oral health that could assist physicians to ascertain who required referral to the dentist. Admission polypharmacy was common and patients who took more than five medications

daily were more likely to require referral to the dentist, but apart from this, it was not possible to categorise patients requiring dental referral based on their admission and in-hospital health characteristics. This was a cross-sectional study which limited the implications that can be drawn from the results.

A 6-year retrospective medical record audit revealed that it is not common for older patients admitted to TQEH to be referred to the on-site dental clinic. The results must be viewed in context, the focus of the hospital admission is to restore patient's health so that they are well enough to be discharged home. However, given that many patients experienced an extended length of stay of over 20 days, there could be some consideration to consulting a dentist as part of total patient care.

This study was subject to significant limitations particularly in terms of study design and participant recruitment that resulted in it being an exploratory, pilot style study. The difficulties in participant recruitment led to a survey of Australian orthopaedic surgeons to explore their opinion of the requirement for antibiotic prophylaxis (AP) prior to dental assessments for patients with prosthetic joint replacements. The majority believe AP is required indefinitely and don't recommend dental assessment prior to elective joint replacements. The Australian Arthroplasty Society (ASA) in 2016, published new recommendations on the use of AP for dental treatment, thereby aligning with the Australian Therapeutic Guidelines and international recommendations.

This thesis highlights that conducting dental research in a medical setting is difficult, but these results, including the limitations, can be used to develop robust, longitudinal studies that have the potential to significantly change oral health delivery models for older people.

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A special acknowledgement to all the patients who participated in this study. This is 7-days of not brushing, on an already compromised dentition. There is food throughout, dental and periodontal infection, mobile teeth and lost restorations. No-one wants to have a mouth like this. This is the inspiration for my work.

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McNally CM, Visvanathan R, Liberali S, Adams RJ. Antibiotic prophylaxis for dental treatment after prosthetic joint replacement: exploring the orthopaedic surgeon's opinion. Arthroplasty Today. 2016; 2(3): 123–126.

McNally CM and Liberali S. Oral health: an important consideration in patient care. Medical Journal of Australia. 2016; 205(7): 300.

List of Abbreviations and Acronyms

AA	Anti-angiogenic (in reference to medication)
AAOS	American Academy of Orthopaedic Surgeons
ADA	American Dental Association
ADE	Adverse drug events
ADLs	Activities of daily living
AHPRA	Australian Health Practitioner Regulation Authority
AIHW	Australian Institute of Health and Welfare
ALSA	Adelaide Longitudinal Study of Ageing
AMU	Acute medical unit
AP	Antibiotic prophylaxis
AR	Anti-resorptive (in reference to medication)
ASA	Australian Society of Arthroplasty
ASA-PS	American Society of Anaesthesiologists – Physical Status
ATC/DDD	Anatomical Therapeutic Chemical (ATC)/ Defined Daily Dose (DDD)
BPE	Basic Periodontal Examination
CALD	Culturally and linguistically diverse
CGA	Comprehensive geriatric assessment
cmRCT	Cohort Multiple Randomised Controlled Trial
COPD	Chronic obstructive pulmonary disorder
CPI	Community Periodontal Index
CVA	Cerebrovascular accident
DH	Dental hygienist
DMFS	Decayed missing filled surfaces

DMFT	Decayed missing filled teeth
DON	Director of Nursing
DT	Dental therapist
ED	Emergency department
GEMU	Geriatric Evaluation and Management Unit
GBD	Global Burden of Disease
HNC	Head and neck cancer
ICD-10	International statistical classification of diseases and health related problems 10th revision
interRAI	International Resident Assessment Instrument
IV	Intravenous
LOS	Length of stay
MMSE	Mini Mental State Examination
MNA-SF	Mini-Nutritional Assessment – Short Form
MRONJ	Medication related osteonecrosis of the jaw
MSK	Musculoskeletal conditions
NHS	National Health Survey
NOF	Neck of femur
OHA	Oral health assessment
OHAT	Oral Health Assessment Tool
OHI-S	Oral hygiene index - simplified
OHRQoL	Oral health-related quality of life
OHTs	Oral health therapist
ONJ	Osteonecrosis of the jaw
OPG	Orthopantomograph

PBS	Pharmaceutical Benefits Scheme
PJI	Prosthetic joint infection
PJR	Prosthetic joint replacement
QoL	Quality of life
RACF	Residential aged care facilities
RUDAS	Rowland Universal Dementia Assessment Scale
SADS	South Australian Dental Service
SDAC	Survey of Disability, Ageing and Carers
SGH	Salivary gland hypofunction
SSFR	Stimulated salivary flow rate
THR	Total hip replacement
TQEH	The Queen Elizabeth Hospital
USFR	Unstimulated salivary flow rate
VA	Veteran's Affairs
WHO	World Health Organisation
XI	Xerostomia Inventory

1. Introduction

Ageing presents significant challenges in terms of health care models and our preparedness to manage medical, dental and social complexity. In Australia an older person is defined as being aged 65 years or over, an age that was determined by qualification for the aged pension.[1] An estimated 3.7 million Australians were aged 65 years and older in 2016 and this is expected to double in the next thirty years to 7.5 million by 2046, that will equate to twenty percent of the Australian population.[1]

The most significant change in terms of oral and dental ageing is the shift from edentulousness (the total lack of teeth) to natural tooth retention. Projections from the National Oral Health Survey of Oral Health in Australia estimate that as few as three percent of older Australians will be fully edentulous by 2021.[2] This change in dentition status has resulted in an increase in the elderly of the prevalence of common dental conditions, particularly dental caries and periodontal disease, traditionally associated with younger or middle-aged populations.[2–4] People living in residential care and those with dementia have worse oral health than those who live in the community and have more difficulty accessing dental services.[4]

There are various mechanisms whereby oral health or dentition status impact systemic health. Diabetes or cardiovascular diseases can be worsened by periodontal diseases through the presence of oral micro-organisms in the bloodstream, or the host's inflammatory response.[5,6] Periodontal disease is often the result of inadequate daily oral hygiene increasing the dental plaque load present on the teeth. This can place people with respiratory diseases or infections at an increased risk of aspiration pneumonia.[7,8]

Medication use, particularly polypharmacy, (taking five or more medications daily), can reduce saliva quality and quantity and result in a dry mouth, xerostomia. This condition significantly impacts oral health related quality of life (OHRQoL) and results in a rapid worsening of dental diseases such as dental decay. Speech, chewing and swallowing are all impacted by a lack of saliva and can lead to social isolation in older people.[6,9]

Significant barriers exist for older people in trying to access dental services.[10] Financial considerations and the lack of a perceived need prevent older people seeking out regular and preventive dental care and they more commonly attend when in pain.[10,11] Physical barriers, getting to and from a dental surgery, particularly when living in residential care facilities also prevent people from seeking dental care.[10] These barriers can be exacerbated when older people live in rural or remote areas. Given the high rates of dental disease among older people and the rapid decline of dental health following admission to a residential care facility, alternatives to traditional dental service models need to be explored so that all older people can receive timely access to dental care.[4,12]

1.1 The purpose of the research

This research was driven by my previous exposure to the poor oral health of older people living in residential aged care facilities (RACFs). Oral and dental health deteriorates quickly following admission to an aged care facility and it is difficult to maintain or improve oral hygiene in the residential care setting.[12,13] Gaining access to a dental professional or dental surgery is challenging and the provision of daily of hygiene is often left to people who have limited education in oral health.[10,12] Given the impact poor oral health has on systemic health, alternatives are needed to increase the opportunities for older people to access dental services. Older people are frequently hospitalised for falls, worsening of general medical conditions or because of an inability to cope at home.[14] For many people an acute hospital admission is a pathway to residential care.[12] The lack of regular dental attendance of older people, makes an

acute hospital admission an alternative healthcare setting to investigate a person's oral health status and facilitate a dental care plan that incorporates oral hygiene and dental treatment needs.[15] There are currently no formal oral health factors incorporated into the comprehensive geriatric assessment (CGA), interRAI, which is one of the most widely publicised CGAs.[16]

There is a need for collaboration and improved communication between the medical and dental professions that ensure improved patient outcomes and total patient care. During the course of the PhD candidature, in my clinical practice, I was assisting a patient manage his oral hygiene post-surgery and radiation for head and neck cancer (HNC). He had severe radiation caries (Appendix 1) and during the period we were trying to stabilise his dental health he had an elective hip replacement and was advised to take antibiotic prophylaxis prior to dental appointments. Ultimately, his dental rehabilitation was delayed which further impacted his psychological state as he felt embarrassed by his dental appearance.

This case study did not fit within the main study of my PhD but was timely given the difficulties I had with recruitment due to the recommendation for antibiotic prophylaxis. This was a factor in deciding to conduct the survey of the beliefs of orthopaedic surgeons on the need and timing for antibiotic prophylaxis practices prior to dental treatment following joint replacement surgery.

1.2 The principal findings

The aim of this research was to obtain a better understanding of the oral health status of older people admitted to acute care and to learn how the medical and allied health practitioners currently manage oral health problems. Oral and dental diseases were prevalent in hospitalised older patients. Dental decay, periodontal disease, oral mucosal conditions and ill-fitting dentures were common, and three-quarters of the participants needed a comprehensive

dental assessment. Letters were written to patients General Medical Practitioners (GPs) and Directors of Nursing (DONs), if in residential care, to advise them of the dental findings. Discharge summaries do not routinely report dental or oral health findings.

The majority of participants included in this study were living independently in their own homes prior to their acute care admission with around thirty percent discharged to residential care. As already stated, oral health worsens rapidly in the first three months following admission to an RACF and significant barriers exist to accessing dental care once a person transitions to full-time residential care.[10,13] Oral health information in hospital discharge summaries could assist GPs, DONs and family members understand the oral health status and need for dental intervention.

The study also revealed that there is an under-utilisation of the on-site dental department. Over a six-year period less than ten percent of patients were referred from the Orthopaedic or Geriatric Evaluation and Management Unit (GEMU) wards for a dental assessment.

The findings from this project have the potential to improve oral health outcomes for older people in the following ways:

1. Incorporation of oral health factors, including a visual inspection of the dentition, into the comprehensive geriatric assessment conducted during an acute hospital admission.
2. Utilisation of allied health staff, including speech therapists, pharmacists and nurses, in the provision of dental assessments and referral to dental clinics.
3. Increasing the utilisation of an on-site dental service to assist in giving medical and allied health staff insight into the dental treatment and daily oral hygiene needs of patients.

The overall results of this study are potentially broader than the above points and require further development and investigation. There is a disconnect between the dental and medical

or allied health professions that results in health care being delivered independently. The dental profession needs to market itself beyond the traditional dental surgery and become a more relevant part of primary health care, improving access to dental services for the most vulnerable and needy. And likewise, there needs to be a recognition from medical and allied health that oral health problems do impact on general health outcomes and despite a person's age or capacity, dental treatment is a necessary component of total patient care. This exploratory study has enabled me to gain insight into the difficulties of conducting oral health research in a medical setting, and to the dental and oral health needs of older people living in the community and in aged care facilities. The results of this study will be used to develop and implement a robust, longitudinal oral health study that incorporates all aspects of allied health and oral hygiene intervention measures.

1.3 The structure of the thesis

This thesis starts with a detailed review of the literature concerned with the oral health of older people in general. The majority of research has been conducted in residential aged care facilities and the limitations of this led to the implementation of the present study. The research aims, and objectives are detailed in Chapter 3 and the methods of each aspect of the project are presented in Chapter 4.

The results are presented in four sections (Chapters 5-10) addressing the major aspects of the oral health study

1. The orthopaedic surgeon survey

   This aspect of the research project was implemented early in the study design when it became apparent that there would be significant difficulties in conducting the planned oral health study in the orthopaedic ward. The orthopaedic surgeons at The Queen Elizabeth Hospital (TQEH) were reluctant to allow dental assessments for patients with

total joint replacements due to the potential for the introduction of bacteraemia potentially leading to joint infection. An option to remove the gingival assessment from the study was not accepted. The surgeons were not comfortable with any form of dental examination on their patients. These complications in recruitment were unexpected as antibiotic prophylaxis for dental treatment has not been recommended for patients with prosthetic joints since 2010. The aim of this survey was to determine whether this belief and practice was commonplace and whether surgeons encouraged patients having elective joint replacements to seek a dental assessment prior to surgery.

2. The oral health study

This study was initiated in an attempt to describe the oral health characteristics of older people from a variety of domiciles, given the majority of geriatric dental research has been conducted in the residential care setting. I attempted to establish whether there were general medical characteristics such as: medical comorbidities or in-hospital complications that could indicate the oral health status and therefore result in a dental referral.

2. Medications

a. Polypharmacy
b. Polypharmacy and oral health
c. Anti-resorptive medication

This section of the thesis evolved from the oral health study, where it was found that the majority of patients did have a dental problem that required dental assessment and intervention. In dental practice we are concerned with the number and type of medications patients take as this can lead to dry mouth (xerostomia) and have a significant impact on the rapid progression of common dental diseases and lead to reduced quality of life. The motivation for looking at this was to determine whether

medications were having an impact on salivary flow and whether the number or type of medications used were associated with the need for dental referral.

The specific interest in anti-resorptive medications is again a reflection of dental clinical practice where there is increased interest and concern when a patient has been prescribed these medications whether it is for osteoporosis or to prevent bone metastases following cancer treatment. The condition medication-related osteonecrosis of the jaw (MRONJ) is a potentially debilitating condition that people taking these medications are at risk, albeit very low, of developing.

Many of the participants in this study were prescribed anti-resorptives or had the mode of delivery from oral intake to intravenous or sub-cutaneous injection adjusted during their admission, without having a dental assessment. This is in contradiction of the recommendations and clinical guidelines surrounding the use of these medications. The aim of this aspect of the study was to describe the oral health status of patients taking these medications in light of the potential for developing MRONJ.

3. Dental department utilisation

Finally, this section of the research examined whether there was any change in the number of referrals to the on-site dental department as a result of implementing the oral health study and having a dental hygienist present on the wards for 12 months. There were really few referrals over the six-year period, but they did increase following the study and the increase was sustained. Dental health status was rarely reported in patient discharge summaries, but this does not capture all the detail of the patient discharge where medical and nursing staff may have verbally encouraged patients to seek dental care.

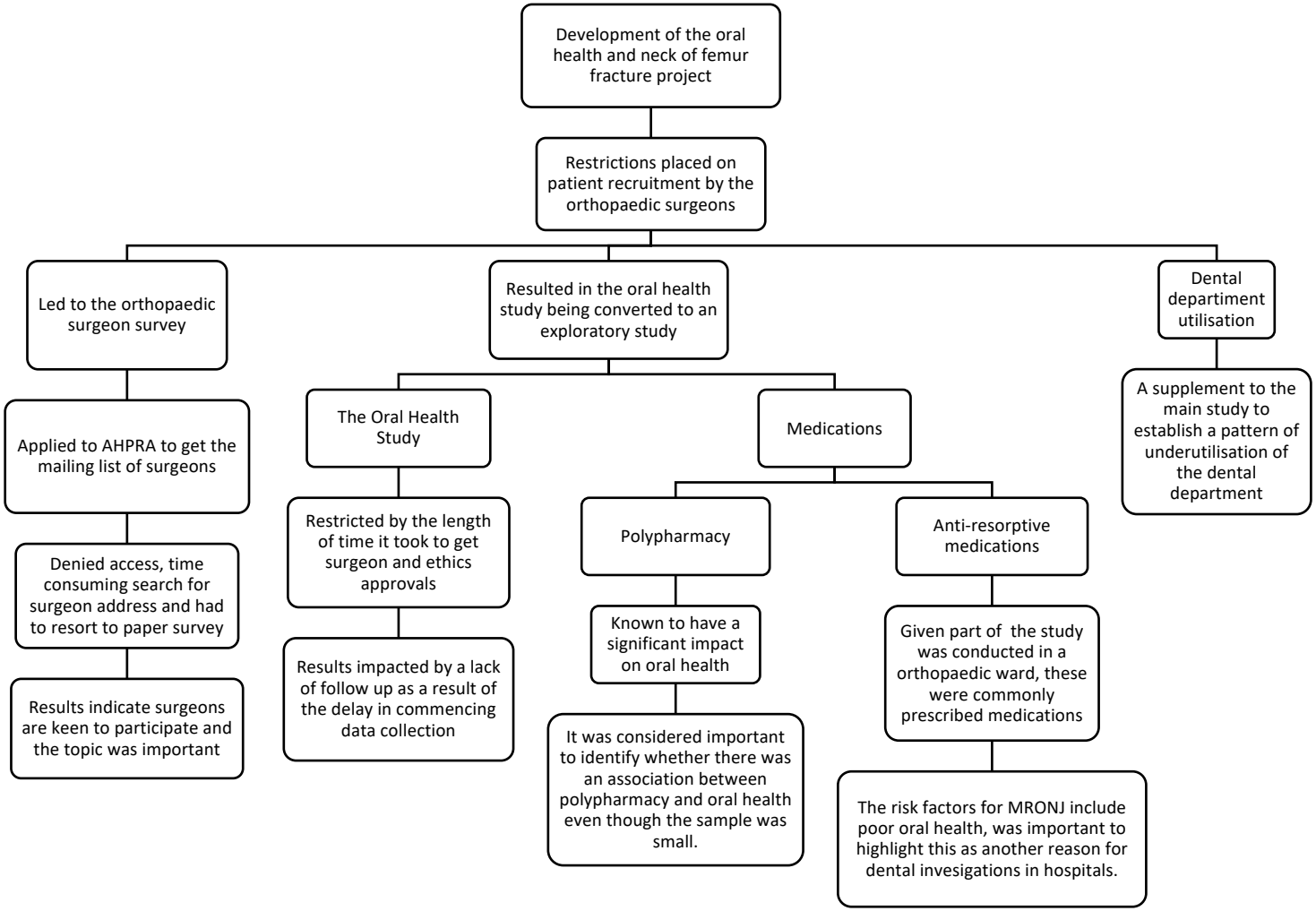
1.3.1 The limitations of the study and potential for future research

The limitations of this study are addressed in detail in Chapter 12. The most significant being the constraints placed on patient recruitment and the lack of follow-up dental assessments following discharge. It was further limited by being a single-centre study. It is recognised that these limitations significantly impacted on the potential for more meaningful data and more generalisable results. However, the findings of this small study are similar to other Australian studies.

The limitations of this study will help to shape a longitudinal study across community, hospital and residential care settings that can result in improved oral health outcomes for older people.

Chapter 13 describes in detail how all of the lessons learned in the conduct of this exploratory study can be used to shape a comprehensive longitudinal study, suggesting that the cohort multiple randomised controlled trial (cmRCT) could be a useful study design that would allow for complete general medical data collection and the incorporation of an oral health assessment without intruding on the daily running of the ward.

Figure 1.1. A flowchart outlining the thesis processes.



2. Review of the literature

Ageing and oral health

2.1 The ageing population

Recent census data has confirmed Australia's ageing population, with an increased median age of 38 years and the proportion of older people, those aged 65 years and older, increasing to from 14 percent in 2011 to 16 percent in 2016.[17] It is predicted that the proportion of older people will continue to increase and reach 23 percent of the total population by 2063.[18]

Living with multimorbidity is an outcome of increased life-expectancy, and despite the majority (72%) of older Australians reporting that they are in good or excellent health, the 2014-15 National Health Survey found that the burden of disease is high in this population.[19,20] Cardiovascular disease and cancer are the leading cause of healthcare burden, with neurological, musculoskeletal and respiratory conditions the next most common.[19]

2.1.1 Hospitalisation

There were 1.6 million emergency department (ED) admissions in 2016-17 for people aged 65 years and older.[19] The main reason for hospitalisation, excluding same-day procedures, were *Diseases of the circulatory system* representing 14.7 percent of admissions.[1,21] The *Injury, poisoning and certain other consequences of external causes* category represented an increasing proportion of older Australian admissions.[1] This classification incorporates falls and accidental injuries.

An acute hospital admission can lead to a decline in oral health through a reliance on others for the provision of toothbrushing and daily oral hygiene care.[22] Poor oral health can also lead to a worsening of general medical conditions while hospitalised, this has been particularly noted in patients with respiratory conditions or those who are intubated.[22,23] Oral health

assessments do not traditionally form part of the comprehensive geriatric assessment and are often neglected in hospital.[12,15,24]

In acute care, as in residential care, it is often the responsibility of the nursing staff to ensure daily oral hygiene is performed.[25] It is assumed that they have the education and ability to complete toothbrushing and make assessments of the severity of dental conditions and recommend dental intervention.[6,25] However, nurses report feeling deficient in their knowledge and experience feelings of negativity towards the provision of daily oral hygiene for patients.[26]

2.2 The ageing dentition

Oral health incorporates dental caries and periodontal disease, the two most common preventable oral health conditions, as well as the additional aspects of being able to eat, speak and socialise without pain or dysfunction.[19] The rate of older people having no natural teeth, being edentulous, has been decreasing and was 19 percent in 2013 down from 36 percent in 1987-88.[19] The change in dentition status has resulted in increased prevalence of common dental diseases and therefore an increased risk of systemic infection originating from an oral or dental source.[6]

Dentistry has a low priority for many older Australians with only 51 percent of people aged over 65 years visiting the dentist annually, decreasing to 41 percent of people aged 85 years and older.[1] At the same time, the number of potentially preventable hospital admissions for dental conditions for people aged 65 years and older has increased by 38 percent from 2007-8 to 2013-14.[19]

2.3 Dental and oral health characteristics of older people

2.3.1 Dental caries

Dental caries, tooth decay, is a major public health problem for older people.[4] The prevalence of both coronal and root surface caries, has increased with the shift away from edentulism.[4,20,27] Adults aged over 60 years are developing caries at a rate of one new lesion per year, which is equivalent to or higher than the rate of children under 18 years of age.[28] The United States (U.S.) Surgeon General reported that mouth problems, including dental caries in older adults and disabled populations are the most common unmet need.[6]

A study by Ling *et al*.,[12] of hospitalised older people in New Zealand (NZ) found that two-thirds (70.7%) of participants had dental caries that required treatment, with one-quarter requiring extraction.[12] Hopcraft *et al*.,[20] reported similar rates of untreated caries in a sample of older Victorians living in residential care facilities.

Dental caries is largely a preventable condition. A healthy diet, daily oral hygiene care and routine dental maintenance are necessary for prevention and unfortunately these are aspects of ageing that may be out of the individual's control.[20] Frail older adults, or those with cognitive impairment or dementia are more reliant on others for assistance with daily living and in particular personal hygiene care.[29,30] These people are more likely to have poorer oral health status and are at a greater risk of dental caries.[10,20]

2.3.2 Periodontal disease

The prevalence and severity of periodontal disease, inflammation of the structures that support the tooth, increases with age. Recent Australian studies, in community and residential care settings, have shown that nearly half of people aged 65 years and older have moderate to severe periodontal index scores.[5] Katsoulis *et al.,*[31] in a 2012 hospital-based study found 95 percent of dentate patients (total dentate patients n = 93) had moderate to severe periodontal index scores. A periodontal index such as the Basic Periodontal Examination (BPE)

summarises the periodontal health by dividing the mouth into six sections and giving each section a code, rather than scoring each individual tooth.[32]

Periodontal disease has been implicated as a contributing factor to the worsening of general health, in particular respiratory conditions, cardiovascular diseases and diabetes.[5,6,33] According to Darby[5(p.15)] this association is likely due to '*dissemination of bacteria into the bloodstream and through the effect of inflammatory mechanisms*'. Systemic health and medical conditions can likewise contribute to the deterioration of the periodontal condition.[34] Cognitive impairment, dementia and frailty can all lead to an increase in periodontal inflammation through inadequate daily oral hygiene, particularly toothbrushing.[6,33,34] Reliance on other people for activities of daily living can also contribute to worsening oral health as tasks like toothbrushing are difficult to perform on other people.[29]

2.3.3 Oral mucosal conditions

A period of hospitalisation may lead to deterioration of oral health with increased plaque levels increasing gingival and mucosal inflammation.[22] Oral mucosal conditions are common in older adults with multiple comorbidities and polypharmacy, and are often related to denture use or decreased salivary flow.[6,35] The most likely cause of oral mucosal inflammation is *Candida albicans,* a common commensal, that can lead to angular cheilitis, denture-associated erythematous stomatitis and median rhomboid glossitis.[36] Candida-associated conditions are common and usually easily treated, but they can also be a sign of systemic health problems such as anaemia that present with oral signs including burning sensations and mucosal redness.[36]

2.3.4 Hyposalivation and dry mouth

Hyposalivation is very common in older people and can lead to poor quality of life (QoL) by limiting food choices and making swallowing and talking difficult.[4] The cause of dry mouth is complicated and often associated with specific medical conditions or medication type,

dosage or polypharmacy.[37–39] Reduced salivary flow increases a person's risk of oral disease, particularly dental caries and mucosal conditions.[4,39,40]

Dry mouth may be objective, as in salivary gland hypofunction (SGH), where there is a clinically detectable reduction in saliva below the expected 1ml/1minute or it can be subjective, termed xerostomia, where patients have the sensation of dry mouth, regardless of the amount of saliva they produce.[38,40] In a series of hospital-based studies of older people assessing the saliva quality and quantity of older adults both stimulated and unstimulated salivary flow rates were very low.[37,41–46] Reduced salivary flow has a significant effect on the ability to wear dentures and taste, chew and swallow food, thereby limiting food choices and potentially impacting nutritional status.[47–49]

2.3.5 Oral health-related quality of life

The changing dentition and dental needs of older people coupled with the impact of medical complexity on the mouth have resulted in increased consideration being given to the impact of oral health-related quality of life (OHRQoL).[13] According to Hopcraft[2 (pg 9)] OHRQoL incorporates '*the components of oral pain and discomfort, oral function limitation, oral disadvantage and self-rated oral health*'. There is a complex association between socio-economic factors, dentition status and OHRQoL.[2,13,50] People from low socio-economic backgrounds and people who cannot afford routine dental care often suffer with a greater impact on quality of life from oral and dental problems.[2,6] Older people with dentures often report poorer OHRQoL as do those with reduced salivary flow.[2,50]

People who feel unhappy about the state of their dentition, or have difficulty with communication or eating and swallowing due to reduced saliva are more likely to withdraw from social situations and become isolated.[2] The association between general and OHRQoL is complicated, but social isolation and poor oral health are associated with increased risk of frailty and malnutrition, which in turn can lead to increased risk of falls and functional

decline.[33] Ling *et al*.,[12] suggests that it would be beneficial to incorporate an OHRQoL scale as part of comprehensive geriatric assessments to establish a baseline against which to monitor any subsequent changes.[12]

2.3.6 Association between systemic and oral health

In the older population the relationship between systemic and oral health is symbiotic. All forms of dental disease and poor oral health can impact negatively on systemic health. This has been detailed in this chapter already: a diseased dentition or missing teeth can lead to malnutrition; reduced saliva quantity and quality increases the risk of chewing, swallowing and speech problems and poor oral health decreases quality of life. There are also psychological implications on quality of life associated with poor oral health, including social isolation associated with an inability to talk or eat properly.[6]

The relationship between oral and systemic health has led to the consideration of poor oral health as a new geriatric syndrome.[51,52] Functional decline, frailty, cognitive impairment and dementia can all lead to inadequate oral hygiene homecare which results in increased bacterial load, in the form of dental plaque.[34,51] Older people, particularly those living in residential care settings are most vulnerable to respiratory infections, particularly pneumonia and in the context of poor oral hygiene, aspiration pneumonia.[6,53]

There is a two-way association between diabetes and periodontal disease.[6] People with poor controlled diabetes are three times more likely to have periodontal disease and periodontal infection is known to exacerbate diabetes.[5,6] The links between other aspects of general health such as cardiovascular disease, cognitive impairment and dementia are thought to be due to the inflammatory response usually associated with periodontal diseases.[5,6] There is a plethora of research into the systemic and oral link with work still to do to determine the exact mechanisms.

The lack of a functional dentition can lead to malnutrition and also impact quality of life (QOL) leading to social isolation.[54,55] An inability to chew and swallow food, a dry mouth or pain due to dental diseases can prevent older people from making healthy and nutritious food choices that lead to weight loss and impact on nutritional status as well as lead to increased frailty.[6]

2.3.7 Barriers and access to services

As people age they are less likely to consult a dentist to maintain oral health.[1] In the context of medical complexity it is common for dental and oral health to be given a lower priority.[56] However, for older people there are significant barriers to accessing dental care.[10,57,58] The most likely reason for older Australians not visiting a dentist is the cost but older people also report more difficulty physically being able to access dental facilities.[1,11] It is more complicated for people living in residential care who are reliant on other people to assess their need for a dentist and facilitate access to professional dental services.[10] There is an association between social disadvantage, including level of education, and dental attendance.[57,58]

There is a reported lack of geriatric dental education within undergraduate dental programs resulting in a workforce unprepared to manage the complexities associated with ageing.[59] Dentists report feeling unable to provide adequate dental treatment for patients who unable to attend a dental clinic.[26] Portable dental equipment is not common and is costly to maintain and residential aged care facilities rarely have a treatment room suitable for dentistry.[10,26]

2.3.8 Workforce utilisation

There has been little attempt to incorporate oral health into aged care reforms.[60] With the lack of dental attendance and significant barriers to accessing dental care, traditional models of education and training will need to adapt to allow dental professionals to work across all aspects of the aged care sector.[60] The fields of geriatrics and gerodontology do not form a

major component of most dental programs in Australia despite the recommendation that they be incorporated into general and specialist training programs.[4,59]

Utilisation of other members of the dental team, such as oral health therapists (OHTs), dental hygienists (DHs) and dental assistants will assist in the education and upskilling of nursing and care staff in hospitals and residential care settings.[60] However, despite an increased utilisation of the dental team in the aged care sector in the last ten years, there is still a reluctance to incorporate dentistry into all health settings.[2,60] Therefore it seems likely a multi-disciplinary approach is necessary, where all members of the healthcare team consider oral health as being an important consideration in overall health and well-being.

2.4 Geriatric dental and oral health research

The research investigating the oral health of older people has found high rates of the common dental diseases: caries and periodontitis.[20,61,62] Despite the trend away from edentulism in developed countries, tooth loss leading to the lack of a functional dentition and ill-fitting dentures are major dental issues that impact on general health and nutritional status.[2,4] Cognitive impairment and frailty can also impact on the ability of an older person to perform adequate daily oral hygiene homecare.[34]

2.4.1 Education and intervention studies

In the hospital and residential aged care setting, education and treatment interventions have had a short-term impact on oral health, but little sustained improvement.[61] A recent systematic review exploring effective strategies to motivate nursing home residents to perform daily oral hygiene found that there are examples of promising strategies to support staff in the provision of daily oral hygiene.[63] However, there are difficulties in implementing these strategies and more robust research is required to ensure uptake of these programs.[63]

Intervention studies, with a focus on improving daily oral hygiene, timely access to services

and treatment where necessary have been conducted in Australia and have shown positive results.[64,65] However, the implementation of such programs state or nation-wide is complex as funding and education systems differ across the country.[60]

2.4.2 Residential aged care research

The majority of older Australians live in private dwellings, but despite this, most research into the oral health status of older people has been conducted in the residential aged care setting.[15,66] Collectively this research presents a dire situation of oral health in the institutionalised, residential care sector.[10,20,65,67,68] A 2015 supplement to *Australian Dental Journal* highlighted all aspects of dentistry in relation to ageing, and reported little change since the conclusions drawn from premier work in the field, the Adelaide Dental Study of Nursing Homes conducted in 1998.[2,67] Older people living in residential care have poor oral health and have significant barriers to accessing dental services.[2]

Thomson and Ma[4(p4)] state that, '*...longitudinal study data lend credibility to anecdotal reports of dentitions being ravaged relatively quickly after admission to a nursing home*'.

Transition to residential care usually follows an acute care hospital admission.[69] In 2011 the mean length of stay in residential aged care in Australia was 145.7 weeks (over two and a half years).[2] If oral health deteriorates that rapidly in nursing homes, a hospital may be the last opportunity to assess acute or urgent oral health needs.[4]

2.4.3 Hospital based research

Hospitalisation for older people to stabilise or manage general worsening of a medical condition or as the result of complications of ageing, such as falls, is common.[70] Hospital admissions are often used to conduct a comprehensive geriatric assessment (CGA) and develop a multidisciplinary approach to patient care that hopefully enables the patient to live independently for as long as possible.[70] Dental and oral health do not usually form part of the CGA but should be considered as an important aspect of total patient care.[50]

Pajukoski and Meurman[71] conducted a study in Finland comparing hospitalised and non-hospitalised or community dwelling participants. They considered that because hospitalised participants were most commonly admitted from independent living they should be representative of the general community. However, they found that their general and oral health was more comparable to that of nursing home residents.[71] The hospitalised participants had higher numbers of medical comorbidities and took more medications which was associated with an increase in dry mouth symptoms.[38,43,44]

The Geriatric Oral Science Project incorporated a series of studies conducted in the 1990's comparing the oral health of community-dwelling, hospitalised and nursing homes participants.[7,42,46,72–77] The setting for this study was a US Veteran's Affairs (VA) Hospital which resulted in significant sample bias as the study population was almost 100 percent male. Despite this, the results were similar to the Pajukoski and Meurman *et al*., series of studies.[38,43,44,71,78] Oral health was poor, and the hospitalised participants were more likely to resemble nursing home participants in terms of general and dental health. As part of the Geriatric Oral Science Project, Hildebrandt *et al*.,[76,77] assessed the status of the dentition in terms of a functional occlusion, i.e. teeth that can bite together. The results showed that dental morbidity is a risk factor for an acute care admission. They hypothesised that the dental status of a patient may give an indication into their general health and motivation for disease prevention, including having regular medical and dental check-ups.[76,77]

The majority of geriatric hospital-based studies are cross-sectional in design. They have been replicated in different hospitals across the United States and Europe and show remarkable similarity. There has been minimal improvement in the oral health status over time, and the more recent studies continue to support and push for dental and oral health to be included in the CGA.

A hospital-based study of oral health in older Australians is important because the majority of geriatric oral health data in Australia is derived from residential care. There are few hospital-based studies investigating dental and oral health in older people in Australia.[15,24,79] Kruger *et al.,*[79] conducted a dental examination of 104 patients at public tertiary hospital (Fremantle Hospital) in Western Australia (WA). The majority (32.7%) of participants were admitted for a fractured neck of femur (NOF). Participants were taking an average of 9.3 (SD 4.1) medications daily. They found that despite the majority feeling satisfied with their oral health, three-quarters (76.6%) were considered to be in need of immediate dental care.[79] This study concluded that further research into the oral health condition of older people, not just those in residential care, but the whole population from fully independent to dependent was required.[79] This highlights patient's lack of dental and oral health awareness and potentailly oral health literacy.

Ní Chroínín *et al.*,[15] researched the association between oral health and general medical comorbidities in 202 participants at St. Vincent's Hospital in Sydney, New South Wales (NSW) using the Oral Health Assessment Tool (OHAT), a screening tool used to determine the status of various components of oral health. The lips, tongue, gums, saliva, teeth, dentures, cleanliness and pain are given a score from 0 to 2, 0 indicating best, 2 indicating worst. The OHAT is a screening tool that indicates when referral to a dental practitioner is required, it does not describe specific dental diseases. The assessment was conducted by an OHT and in cases of disease, referral was recommended, and the patient's dentist advised. [15] The study found that poor oral health (as determined by a high OHAT score) was associated with a diagnosis of dementia (OR 2.41, 95% CI: 1.13-5.12, p=0.02) and moderate to severe renal impairment (OR 5.51 95% CI: 1.54-19.69, p=0.009), although there were limitations in the study design that reduced the generalisability of these results.[15] The study assessed patients within the geriatric medicine ward only, other older adults admitted elsewhere in the

hospital were not included. Participants who were considered terminal or who became agitated were also excluded.

Gibney *et al*.,[24] conducted a study investigating the impact hospitalisation has on oral health in two tertiary referral hospitals in Sydney by assessing older participants at admission and on day seven of admission (sample size = 206 participants).[24] They also used the OHAT screening tool. They found that the majority of participants (70%) were admitted to hospital from independent living situations and according to the *Oral Cleanliness* aspect of the OHAT, participants did not have satisfactory oral hygiene prior to admission to hospital.[24] They also found that *Oral Cleanliness* did not improve during the admission. However, the scores for *Lips, Tongue, Saliva, Gums and Tissues* did improve, perhaps due to management of dehydration and nurse supported feeding improving nutritional status.

Both of these studies provide important insight into the oral health of hospitalised older patients in Australia but unlike the Kruger and Tennant study[3] (conducted 14 years ago) they do not present conclusive data on the dental or oral health disease status.

Danckert *et al.*,[80] conducted an oral hygiene audit using The Plaque Index (a four-point scale from 0 to 3) in four acute and rehabilitation hospital settings.[80] Oral hygiene was poor, and The Plaque Index was higher in participants admitted to acute care, interestingly these participants were more likely to require support with their daily oral hygiene care. This study does not present any specific results on dental diseases or make any associations between oral health and general medical well-being.

Conducting research with older people is difficult.[81–83] Recruitment and retention is challenging despite many older people reportedly keen to participate in trials.[81] Considering oral health as part of general health and conducting research in collaboration with medical and allied health professionals could raise the profile of the impact dental disease has on patients and generate a change in the way we manage the oral health of older people.

2.5 Summary

Older people identify key barriers to accessing dental care in the community, with the cost of private dental care the most significant reason. All Australians have access to government funded healthcare, but there are strict eligibility criteria based on financial status to access the public dental services. Dental and oral health decline with age. Increased natural tooth retention, coupled with increase life expectancy, means that this is more of an issue than previously thought. The association between dental and general health becomes more complicated with the presence of a natural dentition.

The majority of admissions to residential aged care occur following a hospital admission.[12] The poor oral health of nursing homes residents is widely reported and it deteriorates rapidly following admission.[4] Therefore, measures to address dental and oral health issues in hospital are critical to the health and well-being of older people, as hospital may be a "last chance" to improve oral health to avoid adverse health consequences.

This review has identified four key aspects of the research that need further exploration:

1. The dental and oral health of patients admitted to hospital,
2. The medication regimen of older patients and the impact on oral health,
3. Factors associated with a hospital admission that effect oral health, and
4. Expansion of oral health research projects beyond geriatric wards.

There is limited Australian literature detailing the oral health of hospitalised older people and how it may impact or is affected by general medical health and medication use. The most recent studies utilised a screening tool rather than a comprehensive dental examination, but even so, describe widespread poor oral health. The use of screening tools, such as OHAT, to detect changes in key dental and oral features, such as teeth, lips and mucosa has limited the opportunity to describe the prevalence of dental disease and therefore the generalisability of oral health problems to the broader older population.[15,24]

There is a need to integrate oral care into general healthcare, reducing the barriers that limit access to professional dental services and increasing the provision of preventive oral health care in general health settings, particularly as older people increasingly stay in their own homes.[51] The acute hospital setting provides a unique opportunity to undertake an oral health assessment of very old, frail or functionally dependent older people, or those who report non regular dental attendance.[78] Discharging patients with a detailed dental assessment and care plan may help to influence the provision of daily oral hygiene of people admitted to nursing homes and would encourage those who are discharged back to the community to seek out dental care.

3. The research aims

The oral health of older people is poor and worsens in the context of medical complexity. There has been a shift in the dentition status of older people in the last thirty years, from edentulous (no natural teeth) to dentate (with natural teeth). This has changed the dental needs of older people with more people at risk of dental infection and requiring dental intervention. However, traditionally older people consider oral health as low priority, and many do not attend the dentist regularly. Therefore, alternative mechanisms for addressing barriers and access to dental services need to be investigated.

Research conducted in the residential aged care sector shows high rates of poor oral health that is often unrecognised or left untreated. Hospital admissions prior to entry into residential aged care may be missed opportunities for identifying and treating dental problems. As highlighted in Chapter 2, there have been few oral health studies conducted in hospitals in Australia. Ní Chroínín *et al*.,[15] Gibney *et al*.,[24] and Danckert *et al*.,[80] all found that the oral health of older patients hospitalised for general medical problems was poor although they were limited to selected populations and did not complete comprehensive dental assessments. Kruger and Tennant[3] in 2016 reviewed Western Australian (WA) admissions data that showed more older adults are being admitted to hospital for oral and dental related infections. An acute care hospital admission presents a unique opportunity for medical and allied health staff to complete a comprehensive geriatric assessment and facilitate appropriate care. Therefore, the motivating question for this research is:

What is the dental and oral health status of older people admitted to acute care hospitals and how is it managed by medical and allied health staff?

3.1 The orthopaedic surgeon survey

Hypothesis: Australian orthopaedic surgeons recommend antibiotic prophylaxis for patients following joint replacement surgery despite the Australian Therapeutic Guidelines no longer recommending this practice.

The three research aims were:

1. To identify beliefs and measure the practice of Australian orthopaedic surgeons regarding the need for and use of antibiotic prophylaxis before dental treatment for patients with prosthetic joint replacement.
2. Investigate whether orthopaedic surgeons recommend a dental assessment before surgery.
3. Identify the waiting period recommended by orthopaedic surgeons for patients before attending the dentist after their joint replacement surgery.

This study is presented in its entirety in Chapter 5.

3.2 The oral health study

Hypothesis: *The oral health of older people admitted to hospital is poor and has an impact on in-hospital complications and extends length of hospital stay.*

The primary research aim: To describe the oral health of older people admitted to hospital; and discuss the association between poor oral health status as defined by dentition status or requiring dental assessment and health outcomes not limited to:

- Number and type of medical comorbidities
- Number and type of in-hospital complications
- Length of hospital stay
- Nutritional status
- Activities of daily living

3.3 Polypharmacy

Hypothesis: The number of medications patients are prescribed, including medications with xerogenic potential, increases during an acute care hospital admission.

Primary research aim: To describe the prevalence of polypharmacy (consuming ≥5 medications daily) in an older hospitalised population and describe the number and type of xerogenic (dry mouth) potential medications people with polypharmacy are taking.

Secondary research aim: To describe the medical comorbidities associated with polypharmacy.

Objectives:

1. Describe the prevalence of polypharmacy on admission and discharge.
2. Identify admission medications with xerogenic potential.
3. Describe the type of medications participants were consuming on admission and the change in medications that occurred at discharge.
4. Describe the medical comorbidities associated with admission polypharmacy.

3.4 Polypharmacy and oral health

Hypothesis: The number of medications patients are prescribed, including medications with xerogenic potential, are associated with poor oral and dental health.

The research aim: To investigate whether medications impact on the oral health of older inpatients, and whether it is possible to predict dental disease based on admission polypharmacy or the types of medications prescribed.

Objectives:

1. Describe the prevalence of polypharmacy in a sample of hospitalised older people.
2. Identify the medications with xerogenic potential.

3. Describe the relationship between oral and dental health characteristics and polypharmacy
4. Describe whether admission polypharmacy and type of medical comorbidities can indicate the need for a dental referral.

3.5 Anti-resorptive medication

Hypothesis: Clinical recommendations for a dental review prior to commencing anti-resorptive medications are not being implemented

The research aim: The aim of this study was to describe the oral health of hospitalised older people who were taking antiresorptive medication for osteoporosis on admission to hospital, or received the medication during their admission, and investigate compliance with recommendations in clinical guidelines regarding dental referral for the prevention of medication-related osteonecrosis of the jaw (MRONJ).

3.6 Retrospective audit of physician referrals to the dental department

Hypothesis: Referrals to the dental department will increase during the period of the oral health study but this increase will not be sustained once the study is completed.

The research aim: The aim of this study was to assess physician referral patterns to the on-site dental department for patients admitted to the Geriatric Evaluation and Management Unit (GEMU) and Orthopaedic (NOF) wards during the years 2011 – 2016.

4. Methods

This chapter outlines the common methods for the oral health study and the retrospective medical record audit. Methods that apply to specific aspects of the study have been separately incorporated into the appropriate results chapter.

4.1 The oral health study

The purpose of this study was to describe the oral health of older patients on admission to hospital and determine whether oral health contributes to a worsening of general health resulting in, for example, an extended hospital stay (Hypotheses 3.2 – 3.5).

4.1.1 Participants and study design

This cross-sectional study was conducted over a 12-month period (September 2013 – August 2014) at a 311-bed tertiary teaching hospital, The Queen Elizabeth Hospital (TQEH), Adelaide, South Australia where there is an on-site dental clinic. This dental clinic is part of the South Australian Dental Service (SADS), the public dental provider in South Australia. There was one full-time equivalent dentist, a dental technician and two dental assistants employed in the unit. The majority of patients are seen as out-patients, but the dental staff do attend the wards when requested.

Participants were recruited from the Orthopaedic ward following a Neck of Femur (NOF) fracture and the Geriatric Evaluation and Management Unit (GEMU). Patients who present at the Emergency Department (ED) with a NOF are admitted directly to the Orthopaedic ward. Whereas a GEMU admission usually follows a short stay in the Acute Medical Unit (AMU) and is reserved for patients who are considered to have the potential to return to their pre-admission level of independence. They are usually independent community dwelling older patients and the aim of their admission is to avoid discharge to a nursing home. In both wards the geriatricians identified patients deemed medically suitable for a dental assessment,

potentially limiting patients who were acutely unwell or with palliative care needs from participating in the study.

Written consent was obtained directly from patients, third-party consent from next of kin was available for those with language difficulties or cognitive impairment. Participation was voluntary, participants or their next of kin could withdraw at any stage during the admission.

The inclusion criteria for the Orthopaedic ward was: patients aged 65 years and older, admitted for a neck of femur fracture (NOF) (as these patients were under the care of the ortho-geriatrics team) and had surgical repair by internal fixation. Participants were excluded from the dental assessment, at the request of the orthopaedic surgeons, if they had hemi or total hip arthroplasties due to the orthopaedic surgeon's concern for the potential of infection via the hematogenous route from an invasive dental examination. Inclusion criteria for the GEMU were: patients aged 65 years and older, not requiring palliative care.

A dental hygienist [Clare McNally, MPhil (Dent), GradCertHealthProm, AssocDegDH] registered with the Australian Health Practitioner Regulation Agency (AHPRA) who has previous experience collecting oral health data in the Victorian Nursing Home Study, conducted the oral health assessments.[10]

Figure 4.1 outlines the number of admissions to the Orthopaedic and GEMU wards and the number of participants sampled from each.

4.1.2 Selection bias

To assess participant selection bias in the sample, the general health characteristics of those receiving an oral health assessment were compared to age and gender matched patients who were admitted during the same 12-month period but not given an oral health assessment. Admission data from the Orthopaedic and GEMU wards was obtained. The orthopaedic list was screened for NOF fractures only. The patients were matched for age and gender against the oral health assessment participants. A sample of 2:1 ratio (2 patients for every patient

recruited to the oral health arm) was generated. After screening medical records to confirm age and reason for admission, a sample of 146 (57 NOF: 89 GEMU) was selected. These patients are referred to as the 'no oral health assessment' group.

4.1.3 Ethical considerations and approval

People with all levels of cognitive impairment are often discounted from ageing studies due to the inability to gain informed consent. It was important that this sector of the older population be incorporated in the study, due to the known poor oral health status of these people and the increased likelihood that they will be discharged to a residential aged care facility following an acute hospital admission.[12]

The Queen Elizabeth Hospital is located in an area where there are a lot of migrant populations who did not have English as a first language. It was important to ensure these patients were able to be included in the study. Where English was not a first language, or where patients had difficulty with reading or writing English, third-party, next of kin consent was permitted.

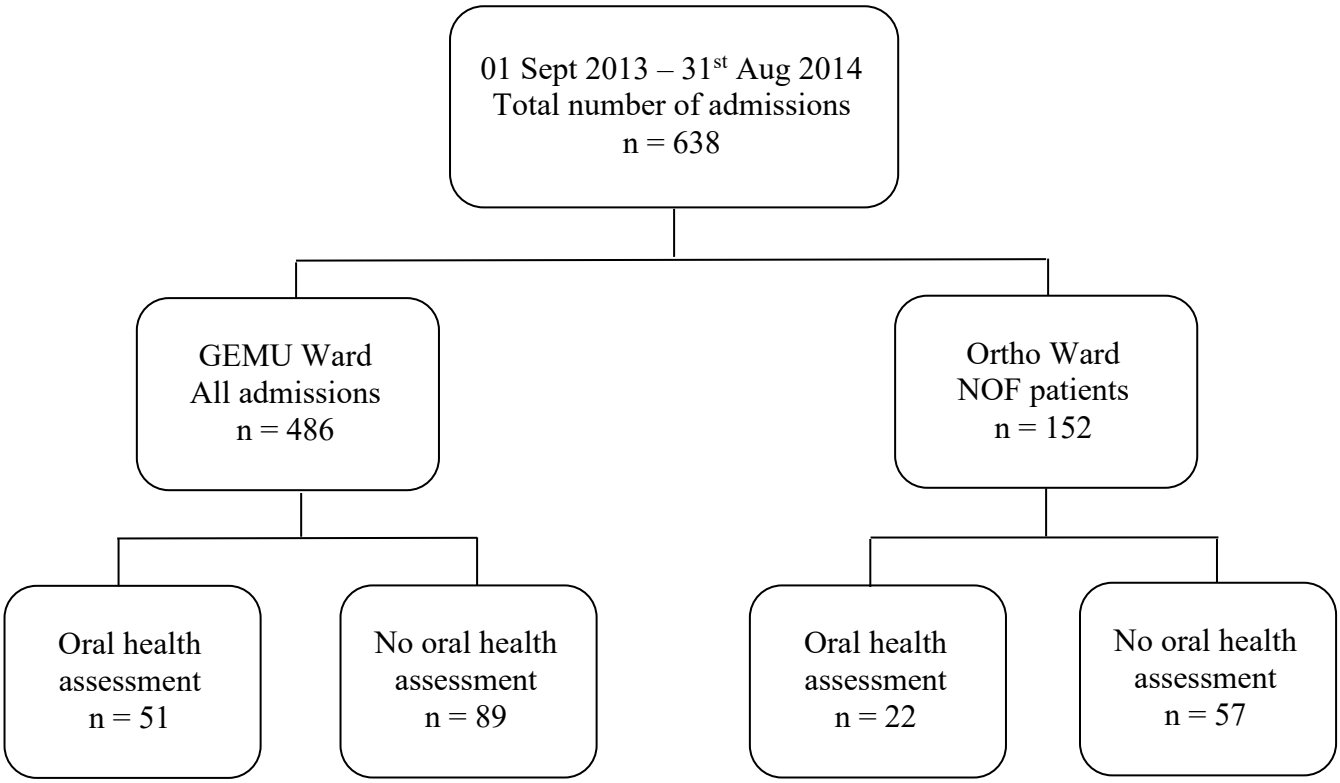
One researcher (Clare McNally) had responsibility for the patient data, which was kept in a locked filing cabinet and on a secure University of Adelaide/South Australian Health computer. Patient data was de-identified as it was entered and collated in the statistical analysis program and has been stored securely in The Basil Hetzel Institute in accordance with the Human Research Ethics Committee (HREC) requirements.

Approval for the study was obtained from the HREC (TQEH/LMH/MH), Central Adelaide Local Health Network. The approval number for the oral health study (Chapters 6, 7, 8 and 9) is HREC/13/TQEHLMH/80.

4.1.4 Statistical methods

Categorical measures were summarized as percentages with counts; Pearson's Chi-square test or Fisher's Exact test were used to assess group differences as appropriate. Continuous data were summarized using means with standard deviation and range. The Wilcoxon test was used in lieu of the paired Student's t-test and the Mann Whitney U test in lieu of the t-test for independent samples to assess differences due to violations of normality. Univariate and multivariate logistic regression analyses were used to explore associations between predictor variables and binomial dependent variables. Factors that were significantly associated with poor oral health on univariate analysis were included in multivariable modelling. All tests were two-tailed and assessed at the 5% alpha level. The analyses were completed using SAS v9.4 (SAS Institute Inc., Cary, NC, USA) and SPSS v25.0 (IBM SPSS Statistics for Macintosh, Armonk NY: IBM Corp).

Figure 4.1. Participant recruitment flowchart



4.1.5 The oral health assessment

The WHO Oral Health Survey: basic methods[84] and recommendations made by Terezakis *et al.,*[22] in their systematic review of the impact of hospitalisation on oral health were used to develop the research protocol. Participants were also asked a series of questions about their oral health and dental history (Appendix 2).

- Extra and Intra Oral Assessments

The extra oral assessment was conducted both visually and through external palpation of the head and neck. The intra oral assessment consisted of a visual inspection of the mucosa of the cheeks, tongue, floor of mouth and throat, pillars of fauces and tonsillar region. (Table 4.1)

- Prosthetic Status

Removable prosthesis (dentures) were assessed for fit and then removed to check quality and cleanliness. (Table 4.2)

- Oral Hygiene Index

The oral hygiene index being used in this study was the Greene and Vermillion Oral Hygiene Index- Simplified (OHI-S).[85] This index was chosen because it classifies debris, including food and plaque as well as calculus. It is minimally invasive and quick to administer. (Table 4.3)

- Dentition

The dentition was scored using a similar method to the Decayed, Missing, Filled Teeth (DMFT) score. The coding is from the WHO Oral Health Survey and incorporates an assessment of each tooth as well as the root surface of each tooth (Table 4.4).

Table 4.1 The components of the extra and intra oral assessment

Category	Possible results
Chief dental complaint	▪ None ▪ Pain from natural teeth ▪ Pain related to denture ▪ Halitosis ▪ Bleeding gingiva ▪ Sensitivity ▪ Not recorded
E/O Examination	▪ Normal E/O appearance ▪ Ulceration, sores, erosions, fissures (head, neck, limbs) ▪ Ulceration, sores, erosions, fissures (nose, cheeks, chin) ▪ Ulceration, sores, erosions, fissures (commissures) ▪ Ulceration, sores, erosions, fissures (vermilion border) ▪ Abnormalities of upper and lower lips ▪ Enlarged lymph nodes (head and neck) ▪ Other swellings of face and jaws ▪ Not recorded
Oral Mucosa Condition	▪ No abnormal condition ▪ Leukoplakia ▪ Lichen planus ▪ Ulceration (aphthous, herpetic, traumatic) ▪ Acute necrotising gingivitis ▪ Candidiasis ▪ Abscess ▪ Other Condition ▪ Not recorded
Oral Mucosa Location	▪ Vermilion border ▪ Commissures ▪ Lips ▪ Sulci ▪ Buccal mucosa ▪ Floor of mouth ▪ Tongue ▪ Hard and/or soft palate ▪ Alveolar ridges/ gingival ▪ Additionally, the pillars of fauces and tonsillar region ▪ Not recorded
Oral Mucosa Photos	▪ No ▪ Yes ▪ Not recorded
Oral Mucosa Diagram	▪ No ▪ Yes ▪ Not recorded

4.1.6 Basic Periodontal Examination

The Basic Periodontal Examination (BPE) was used to assess periodontal health in this study. The mouth is divided into sextants. A probe is passed between the tooth and gum to check the clinical attachment loss and support around the tooth. The highest score is allocated to the entire sextant, ranging from 0 – 4 (Table 4.5).[32] The results of the BPE indicate whether simple debridement or more detailed periodontal assessment is required.[86] The WHO Oral Health Survey utilises the Community Periodontal Index (CPI) which was not used in this study as it does not assess each tooth or give an indication of the next stage of periodontal treatment required.[84,86]

4.1.7 Intra-oral photographs

Intra-oral photographs were taken of any suspicious lesions or areas of concern and sent to the senior dental specialist and co-supervisor, Dr. Sharon Liberali, for review. Radiographs were not taken as part of the assessments.

4.1.8 General health assessment

Electronic and hard copy medical records were used to obtain information concerning comorbidities, admission and discharge medications and in-hospital complications and length of hospital stay.

4.1.9 Comorbidities and complications

Comorbidities and complications were initially classified by anatomical system or medical category according to the International Statistical Classification of Diseases and Related Health Problems (ICD-10.).[21] They were then further refined by the type of disease within the anatomical system.

4.1.10 Medications

Medications were classified according to the WHO Collaborating Centre for Drug Statistics Methodology ATC/DDD system.[87] Polypharmacy was considered to be consuming five or more medications daily, both over the counter and prescription medications were included.[88]

Table 4.2. The prosthetic status

Category	Possible results
Prosthetic Status Maxilla	▪ No prosthesis ▪ Bridge ▪ More than 1 bridge ▪ Partial denture ▪ Both bridge and partial dentures ▪ Full removable denture ▪ Not recorded
Prosthetic Status Mandible	▪ No prosthesis ▪ Bridge ▪ More than 1 bridge ▪ Partial denture ▪ Both bridge and partial dentures ▪ Full removable denture ▪ Not recorded

Table 4.3 The oral hygiene status

Category	Possible results
Debris index	▪ Complete in table to determine total ▪ No debris or stain present ▪ Soft debris covering not more than one third of the tooth surface, or presence of extrinsic stains without other debris regardless of surface area covered ▪ Soft debris covering more than one third, but not more than two thirds, of the exposed tooth surface ▪ Soft debris covering more than two thirds of the exposed tooth surface ▪ Debris Index = (The buccal-scores) + (The lingual-scores) / (Total number of examined buccal and lingual surfaces).
Calculus index	▪ Complete in table to determine total ▪ No calculus present ▪ Supragingival calculus not more than third of the exposed tooth surface ▪ Supragingival calculus covering more than one third but not more than two thirds of the exposed tooth surface or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth or both ▪ Supragingival calculus covering more than two third of the exposed tooth surface or a continuous heavy band of subgingival calculus around the cervical portion of the tooth or both. ▪ Calculus Index = (The buccal-scores) + (The lingual-scores) / (Total number of examined buccal and lingual surfaces).
Oral hygiene index	▪ Debris Index + Calculus Index
Who is responsible for your daily oral hygiene homecare	▪ Self ▪ Family member ▪ Nurses/Care staff ▪ Other …..(describe) ▪ Not recorded
Description of who performs OH	Free text

Table 4.4. The coding system for the dentition

Crown	Root	Status
0	0	▪ Sound
1	1	▪ Decayed
2	2	▪ Filled, with decay
3	3	▪ Filled, no decay
4	-	▪ Missing as a result of caries
5	-	▪ Missing, any other reason
6	-	▪ Fissure sealant
7	7	▪ Bridge abutment, special crown or veneer/implant
8	8	▪ Unerupted tooth
T	-	▪ Trauma
9	9	▪ Not recorded

Table 4.5. The categories of the Basic Periodontal Examination

Basic Periodontal Examination Categories
0. No pockets exceeding 3mm in depth and no calculus or overhangs of fillings and no bleeding occurs after gentle probing
1. No pockets exceeding 3mm in depth and no calculus or overhangs of fillings, but bleeding occurs after gentle probing
2. No pockets exceeding 3mm in depth, but dental calculus or other plaque retention factors are seen at, or recognised underneath the gingiva
3. If the coloured area of the probe remains partially visible when inserted into the deepest pocket
4. If at one or more teeth the coloured are of the WHO probe disappears into the inflamed pocket indicating pocket depth of 6mm or more
5. If there is total loss of attachment at any site is 7mm or more, or if a furcation can be probed. The asterix denotes that a full periodontal examination of the sextant is required regardless of the BPE score
9. Not recorded

4.1.11 The Mini-Mental State Examination

The Mini-Mental State Examination (MMSE) was used to assess the cognitive status of participants. This tool in use since 1975, has been validated and is regularly used to screen for cognitive impairment and dementia.[89,90] This tool is used within both the Orthopaedic and GEMU wards to determine dementia status (Table 4.7).

Table 4.7. The scoring system for the MMSE.

Method	Score	Interpretation
Single cutoff	<24	Abnormal
Range	<21 >25	Increased odds of dementia Decreased odds of dementia
Education	21 <23 <24	Abnormal for 8th Grade education Abnormal for high school education Abnormal for college education
Severity	24-30 18-23 0-17	No cognitive impairment Mild cognitive impairment Severe cognitive impairment

The Rowland Universal Dementia Assessment Scale (RUDAS) system is used for culturally and linguistically diverse (CALD) people who require a dementia assessment.[91] It assesses patients in memory, visuospatial orientation, praxis, visuconstructional drawing, memory recall and language. Similarly, to the MMSE there is a cut off score (≤ 22) that indicate\ cognitive impairment and the lower the score, the greater the impairment.

4.1.12 Activities of daily living

The Katz Activities of Daily Living score (Katz ADL) is a simple tool that can be administered and assessed in a short period of time. Participants are asked six questions assessing their ability to independently bathe, dress, toilet, transfer, feed and about their

continence. A score of less than two out of six indicates severe functional impairment.[92] Pre-morbid and during admission Katz ADL was determined.

4.1.13 General food and nutritional measurements

The Mini-Nutritional Assessment Short Form (MNA-SF) was used to diagnose malnutrition.[93] A series of questions used in the National Health Survey (NHS) 2007/08[94] and the Adelaide Longitudinal Study of Ageing (ALSA)[95] were also asked. These are self-reported ratings of oral health and nutritional intake.

The above listed assessments are the key medical assessments presented in the thesis. The full detail of all the data collected is available at Appendix 2.

4.2 Dental department utilisation

This component of the study was conducted to determine if the presence of a dental hygienist on the Orthopaedic and GEMU wards had an impact on the number of patients referred to the on-site dental clinic by the geriatricians and physicians (Hypothesis 3.6).

4.2.1 Methods

A six-year (January 2011 – December 2016) retrospective audit was undertaken to determine the referral patterns to the on-site dental clinic before, during and after the oral health study was implemented. A full list of patients admitted to the Orthopaedic and GEMU wards was obtained from The Queen Elizabeth Hospital (TQEH) medical records department. The inclusion criteria were patients aged 65 years and older, and the orthopaedic ward patient list was screened for patients admitted for a NOF, as only NOF patients were recruited for the oral health study.

The number of participants chosen for recruitment is presented in Table 4.8 and was based on the number of participants recruited to the oral health study. For each year of the audit, 100 GEMU participants and 50 NOF participants were selected. The total sample population was

900. To select the participants a number was assigned to all the patients admitted each year and a random number generator was then used to select patients from each list. This process was completed for each ward to ensure 100 from the GEMU and 50 from the Orthopaedic wards were sampled.

The medical records of the 900 participants were screened and a total of 95 (10.5%) were excluded (Table 4.8). Forty (of 95, 44.4%) of participants had no discharge summary for the admission. Thirty-five (of 95, 36.7%) had a duplicate recording for the admission, this occurred when there was a long hospital stay, these records were merged and considered as one admission. The final sample of 805 participants included 543 (67.5%) GEMU admissions and 262 (32.5%) NOF admissions.

Electronic medical records were then accessed, and the following data recorded for each patient:

1. Age
2. Sex
3. Length of hospital stay (days)
4. Reason for admission
5. Number of comorbidities
6. Number of in-hospital complications
7. Number of admission medications
8. Number of discharge medications
9. Dental referral (Yes/No)
10. Reason for dental referral
11. Description of oral health status included in discharge summary
12. Died during admission

A copy of the research protocol is presented at Appendix 3.

4.2.2 Ethical considerations and approval

This retrospective medical record audit required no patient contact and was considered of low or negligible risk. One researcher collected and collated the data from the electronic medical record system and immediately de-identified the patient information.

Approval for the study was obtained from the Human Research Ethics Committee (TQEH/LMH/MH), Central Adelaide Local Health Network. The approval number for the retrospective audit investigating dental referral patterns is Q20151112 (Chapter 10).

4.2.3 Statistical analysis

Categorical measures were summarized as percentages with counts; Pearson's Chi-square test or Fisher's Exact test were used to assess group differences as appropriate. Continuous data were summarized using means with standard deviation and range. The Wilcoxon test was used in lieu of the paired Student's T-test and the Mann Whitney U test in lieu of the t-test for independent samples to assess differences due to violations of normality. All tests were two-tailed and assessed at the 5% alpha level. The analyses were completed using SAS v9.4 (SAS Institute Inc., Cary, NC, USA) and SPSS v25.0 (IBM SPSS Statistics for Macintosh, Armonk NY: IBM Corp).

Table 4.8. The participant sampling for the retrospective audit of dental referrals [n (%)]

	Ward	No. of Admissions	Number Sampled	No. excluded	Reason for exclusion	Total
2011	NOF	169	50 (29.6)	3 (6.0)	1 – duplicate recording for admission 1 – transferred to private hospital 1 – aged < 60 years	47 (94.0)
	GEMU	563	100 (17.8)	8 (8.0)	7 – duplicate recording for admission 1 – died at the hospital before GEMU admission	92 (92.0)
2012	NOF	180	50 (27.8)	4 (8.0)	1 – no discharge summary 3 – transferred to private hospital	46 (92.0)
	GEMU	489	100 (20.4)	8 (8.0)	4 – no discharge summary 4 – duplicate recording for admission	92 (92.0)
2013	NOF	159	50 (31.4)	5 (10.0)	1 – duplicate recording for admission 4 – transferred to private hospital	45 (90.0)
	GEMU	488	100 (20.5)	8 (8.0)	5 – no discharge summary 3 – duplicate recording for admission	92 (92.0)
2014	NOF	157	50 (31.8)	9 (18.0)	1 – no discharge summary 7 – duplicate recording for admission 1 – aged <60 years	41 (82.0)
	GEMU	501	100 (19.9)	12 (12.0)	7 – no discharge summary 5 – duplicate recording for admission	88 (88.0)
2015	NOF	172	50 (29.1)	8 (16.0)	2 – duplicate recording for admission 6 – transferred to private hospital	42 (84.0)
	GEMU	591	100 (16.9)	10 (10.0)	8 – no discharge summary 2 – duplicate recording for admission	90 (90.0)
2016	NOF	150	50 (33.3)	9 (18.0)	4 – no discharge summary 2 – duplicate recording for admission 1 – transferred to private hospital 1 – transferred to other public hospital 1 – aged < 60 years	41 (82.0)
	GEMU	677	100 (14.8)	11 (11.0)	10 – no discharge summary 1 – duplicate recording for admission	89 (89.0)
Total		4,296	900 (20.9)	95 (10.5)		805 (89.4)

5. The orthopaedic surgeon survey

The original aim of the oral health project was to investigate the oral health of patients with a neck of femur fracture and explore any association with increased in-hospital complications, length of stay and mortality. The orthopaedic surgeon team, however, were concerned about allowing patients who had recent joint replacement surgery to have a dental examination due to the potential for bacteraemia and possible joint infection via the hematogenous route. An option to complete the examination without the gingival assessment was also denied. In 2013 when this study was initiated, the Arthroplasty Society of Australia (ASA) was following guidelines that referred to recommendations made by Scott *et al*.,[96] in 2005. The recommendations were that dental treatment be delayed until 3-6 months after joint replacement and that for any invasive treatment antibiotics be administered one hour prior to the procedure. There was no recommendation for surgeons to refer to the dentist for an oral health clearance prior to the surgery. These guidelines were consistent with international recommendations in 2005.

In 2010, the Australian Therapeutic Guidelines were updated removing the requirement for antibiotic prophylaxis for all patients with a prosthetic joint and the most recent (2018) update advises that the risks of prophylaxis far outweigh the benefit.[97] Readers of the Australian Therapeutic Guidelines are referred to the American Association of Orthopaedic Surgeons-American Dental Association (AAOS-ADA) joint practice guideline.[98] This guideline highlights the importance of seeking a dental opinion prior to elective joint replacement and ensuring that anyone with a joint replacement maintains good oral hygiene and seeks regular dental maintenance.

It was assumed that the surgeons would be following the 2010 therapeutic guidelines and not require any antibiotic prophylaxis. However, they set specific recruitment criteria excluding any patient with a hemi- or total hip replacement, severely limiting the potential sample.

This survey was initiated to determine whether the requirement for antibiotic prophylaxis at The Queen Elizabeth Hospital (TQEH), prior to a dental assessment was commonplace among Australian Orthopaedic Surgeons. We found that the number of prosthetic joint infections (PJIs) were very low and that a quarter of surgeons believed the PJIs were the result of dental treatment. Nearly three-quarters (186/260, 71.5%) believe that antibiotic prophylaxis is required indefinitely for dental treatment following a prosthetic joint replacement, but only 43 (14.5%) routinely recommended patients seek a dental consult prior to joint replacement surgery.

There were limitations with the survey design and the Australian Health Practitioner Regulation Agency (AHPRA) denied an application to access mailing (email and business) addresses of orthopaedic surgeons but despite this the survey achieved a good response rate (n=314, 49.6%).

Interestingly, in 2016 following the completion of this survey, the ASA produced a new position statement aligning with the therapeutic guidelines and the AAOS-ADA joint position statement (Appendix 4). With greater insight and given the changes introduced by the ASA is worth surveying orthopaedic surgeons again in the next few years to determine whether their practices have changed.

Statement of Authorship

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Principal Author

Name of Principal Author (Candidate)	Clare McNally		
Contribution to the Paper	Study conception and design, data collection, analysis and interpretation, manuscript writing and editing		
Overall percentage (%)	85%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature	[redacted]	Date	6/6/19

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate to include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Original research

Antibiotic prophylaxis for dental treatment after prosthetic joint replacement: exploring the orthopaedic surgeon's opinion

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Background: Antibiotic prophylaxis before dental treatment is routinely recommended by orthopaedic surgeons to prevent prosthetic joint infection (PJI). This recommendation is at odds with current guidelines.
Methods: A postal survey of 9 checkbox or short-answer questions was completed by 633 orthopaedic surgeons.
Results: The majority of respondents (n ¼ 186 of 260, 72%) believe that antibiotic prophylaxis is required indefinitely for dental treatment. A small number (n ¼ 43, 15%) seek a dentist's opinion before elective joint replacement. The surgeons reported low numbers of PJIs, although 24% (n ¼ 68 of 280) believed that they were associated with dental treatment.
Conclusions: Australian orthopaedic surgeons continue to recommend antibiotic prophylaxis for dental treatment. The recording of PJI in relation to dental procedures into clinical registries would enable the development of consistent guidelines between professional groups responsible for the care of this patient group.

Introduction

Prosthetic joint infection (PJI) is associated with significant morbidity, functional decline, potential implant failure, and mortality; therefore, measures to prevent its occurrence are important [1,2]. The majority of PJIs occur after intraoperative contamination from airborne pathogens or microorganisms present on the patient's skin. Late PJIs, 1-2 years after surgery, are often due to bacterial seeding via the hematogenous route, from the oropharynx, gastrointestinal, or genitourinary tract [3,4].

Antibiotic prophylaxis before dental treatment is used to prevent late PJI infection that could occur after invasive dental treatment. There are risks associated with antibiotic prophylaxis including the potential for an increase in the number of adverse reactions, including antibiotic sensitivity and anaphylaxis, as well as increasing the prevalence of multidrug-resistant bacterial infections [5-7].

There is limited evidence demonstrating an association between dental treatment and PJI [1]. Case reports and retrospective studies that suggest a relationship between dental treatment and PJI are usually cited as justification for continuing to use antibiotic prophylaxis [8-11]. Current international guidelines do not support the use of antibiotic prophylaxis to prevent PJI [7,12-15]. The Australian Therapeutic Guidelines recommend reducing the risk of infection by comprehensive medical management perioperatively [15]. Despite these recommendations, some dental and orthopaedic surgeons continue to prescribe antibiotic prophylaxis hoping to protect patients from the dire consequences of PJI [16,17].

The aims of this survey were to (1) measure the practice of Australian orthopaedic surgeons on the need for, and use of, antibiotic prophylaxis before dental treatment for patients with

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prosthetic joint replacements, (2) investigate whether orthopaedic surgeons recommend a dental assessment before surgery, and (3) identify how long they recommend patients wait before attending the dentist after their joint replacement.

Material and methods

There were 1210 orthopaedic surgeons registered with the Australian Health Practitioner Regulation Agency (AHPRA) according to the 30th June 2012 annual report [18]. We initially planned to survey the entire orthopaedic surgeon population because of evidence of a poor response rate in similar studies which indicated difficulty encouraging participation [16,17,19]. However, a comprehensive list of surgeon names and addresses was not made available by either AHPRA or the professional association representing orthopaedic surgeons. Without comprehensive mailing lists, it was not possible to survey all surgeons. The study sample was therefore determined by surveying all surgeons in the smaller states and territories—Tasmania, Australian Capital Territory, the Northern Territory—and half the number of surgeons in the larger States—New South Wales, Queensland, South Australia, Victoria, and Western Australia. In total, 633 surgeons were identified, just over half of all orthopaedic surgeons registered in Australia (Table 1).

Internet searches of the Royal Australian College of Surgeons and Health Engine websites were used to gather potential participant names and addresses [20,21]. If letters were returned to sender because of an incorrect address, further online searches of the AHPRA and Yellow Pages websites were conducted to obtain the correct or updated contact details [22,23].

The survey was developed by a multidisciplinary dental and medical team (the authors) and did not include an orthopaedic surgeon. A mixed-mode approach was adopted, with surgeons given the option to access the survey online or complete and return a hard copy. There were 9 short-answer or checkbox questions that complied with the requirements of SurveyMonkey, the free online survey tool used (Table 2) [24]. Based on available literature, the questions assumed that surgeons recommended antibiotic prophylaxis for dental procedures that were likely to induce a bacteremia [2,16].

The hard copy questionnaire consisted of one double-sided A4 sheet of paper. Unique identification numbers were hand written on each survey, and each covering letter was personally signed. The survey was posted to surgeons and a follow-up reminder was mailed 4 weeks later. Data collection occurred between October 2013 and January 2014.

Ethics approval was obtained from the Human Research Ethics Committee (HREC; The Queen Elizabeth Hospital/Lyell McEwin Hospital/Modbury Hospital (TQEH/LMH/MH); HREC reference number: HREC/13/TQEHLMH/55). The study was funded by Aged and Extended Care Services at the Queen Elizabeth Hospital. No external funding was used. Descriptive results are presented; analysis was performed using SPSS, version 21.0 [25].

Table 1
The number of registered orthopaedic surgeons and survey response rate by state and territory, n (%).

State	Registered	Sampled	Returned usable surveys
ACT	25 (2.1)	23 (92.0)	12 (52.2)
NSW	396 (32.7)	202 (51.0)	100 (49.5)
NT	7 (0.6)	4 (5.7)	1 (25.0)
QLD	260 (21.8)	129 (49.8)	64 (49.6)
SA	111 (9.2)	56 (50.5)	30 (53.6)
TAS	21 (1.7)	20 (95.2)	11 (55.0)
VIC	278 (23.0)	138 (49.6)	66 (47.8)
WA	112 (9.3)	61 (54.5)	30 (49.1)
Total	1210 (100.0)	633 (52.3)	314 (49.6)

ACT, Australian Capital Territory; NT, Northern Territory; NSW, New South Wales; QLD, Queensland; SA, South Australia; TAS, Tasmania; VIC, Victoria; WA, Western Australia.

Table 2
The survey questions and response options.

1. Gender
   - Male
   - Female
2. How many years have you been practicing as an orthopaedic surgeon?
   Enter number
3. How many prosthetic hip replacements do you perform each year?
   - 1-10
   - 11-20
   - 21-30
   - 30þ
4. What percentage of your patients have developed a prosthetic joint infection (please consider any joint not just hip)?
   - Early - %
   - Delayed - %
   - Late - %
5. Do you refer patients to a dentist prior to an elective prosthetic joint replacement?
   - No
   - Yes
6. How long after the joint replacement surgery do you recommend your patients wait before seeking dental treatment?
   - <3 months
   - 3-6 months
   - 6-12 months
   - >12 months
   - Other - Describe
7. In your opinion do patients with a prosthetic joint require antibiotic prophylaxis prior to dental treatment?
   - No
   - Yes
8. In your opinion, for how long after the joint replacement surgery is antibiotic prophylaxis required for dental treatment?
   - 3 months
   - 6 months
   - 12 months
   - Indefinitely
9. Do you believe that any PJIs developed by your patients were the result of dental treatment?
   - No
   - Yes
     If yes how many - %

Results

Of the 633 surgeons approached, 314 (49.6%) usable surveys were returned and analyzed (Table 1). Sixty-two (9.8%) surgeons advised that they do not perform joint replacements and were excluded from the analysis. One-third (n ¼ 238, 37.6%) did not complete or return the survey or were no longer at the practice address. Of the 314 returned surveys, only 11 (0.04%) surgeons completed the online version.

The majority (n ¼ 297, 96.7%) of respondents were male and had been practicing as orthopaedic surgeons from 1 to 43 years, with 33.9% (n ¼ 105) being in practice between 11 and 20 years. Seventy-two (23.2%) had been in practice <5 years. Two-thirds (n ¼ 190, 67.1%) of the respondents perform >30 joint replacements each year.

Surgeons reported that <2% of their patients experienced a joint infection at any stage after the replacement. One-quarter of the surgeons who responded to this question (n ¼ 68 of 280, 24.3%) believed that PJIs had resulted from dental treatment.

Most respondents (n ¼ 186 of 260, 71.5%) believe that antibiotic prophylaxis is required indefinitely for dental treatment. Some

surgeons commented that this recommendation is dependent on the type of dental procedure required or if the patient currently has dental infection. Recent graduates (n ¼ 61 of 68, 87.1%) with 0-5 years in practice were more likely to recommend antibiotic prophylaxis than surgeons >20 years of experience (n ¼ 44 of 64, 64.7%). Surgeons generally recommend patients wait 3 to 6 months after joint replacement before seeking dental treatment and that antibiotic prophylaxis is required at this time.

Forty-three (14.5%) respondents said that they refer patients to a dentist before elective joint replacement. Twenty-five surgeons (7.8%) added that although they do not routinely refer to a dentist, they do if the patient reports a dental problem before surgery. The decision to refer to a dentist was not influenced by the number of years in practice. Surgeons who had graduated in the past 5 years (n ¼ 60 of 69, 86.9%) were just as likely to seek a dentist's opinion as those who had been practicing for >20 years (n ¼ 54 of 67, 80.6%).

Discussion

The number of hip and knee joint replacements being performed in Australia is increasing with the aging population. In 2014, 95,515 total hip and knee replacements were performed in Australia, and this has increased by 58.6% for hip replacements and 88.3% for knee replacements since 2003 [26]. Infection rates are very low, but an infected prosthetic joint will result in significant morbidity for the patient often requiring revision surgery [1,27,28]. Respondents to this survey reported very low infection rates among their patients but generally considered the outcome of a PJI so dire; all attempts should be made to avoid it.

Consistent with the findings of previous, similar studies, this survey demonstrates that the majority of Australian surgeons still routinely prescribe antibiotic prophylaxis for dental treatment, despite current guidelines indicating they are not beneficial or necessary [16,17]. In a study of Canadian orthopaedic surgeons, 54 of 153 (35%) surveyed reported 85 cases of late hematogenous infection, and they believed that dental treatment was the likely cause and therefore recommend indefinite antibiotic prophylaxis [17]. A study of orthopaedic surgeons working in Nebraska found that 74.5% were likely to prescribe antibiotic prophylaxis before any invasive dental treatment.

There are reports that organisms of oral origin have been identified in a small number of cases (6%-13% of PJIs); thus, it is difficult to prove that a PJI has originated from the oral cavity [29]. There has only been 1 case-control study that examined whether antibiotic prophylaxis for dental procedures reduced the risk of PJI. They found that there was no increased risk of a PJI for patients undergoing high- or low-risk dental procedures whether antibiotic prophylaxis was used or not [1].

Several articles suggest that good oral hygiene is the key to preventing PJI of dental origin and recommend a dental consult before elective joint replacement [8,30,31]. This was not a common practice among the respondents. Yet the utilization of a dentist before the surgery has the potential to negate or minimize the risk of infection from dental origin and establishes an appropriate level of risk for future infection. Referral to a dentist before elective joint replacement surgery, as part of the comprehensive medical management, would seem to be an effective way of reducing the potential for joint infection by oral microflora. The incorporation of a dental consult before joint replacement surgery, as a means of reducing infection, and the need for antibiotic prophylaxis have not been researched. In light of the lack of conclusive evidence for the use of antibiotic prophylaxis, it would be beneficial to incorporate this as a component of future studies.

The response rate of 49.6% in this survey is considered a good result given similar surveys of surgeons have returned 30.9% for an email-only survey [17] and 39.3% for a postal survey [16]. It is reported to be difficult to gain a good response rate from orthopaedic surgeons, with Sprague et al [19] reporting response rates among surgeons as low as 15%. This was made more difficult in our study because of the inability to access a comprehensive database, resulting in sampling surgeons who were retired or deceased, and inaccuracies in available practice postal addresses. A mixed-mode approach, electronic and hard copies, has been shown to be most effective in encouraging surgeons to reply [19]. This survey did not have a good response rate from the electronic survey; however, with access to a complete mailing database, it is advisable to continue to use the mixed-mode approach to encourage a larger response rate. Despite the limitations in data collection, the response rate suggests that this is a topic that orthopaedic surgeons are keen to discuss and engage in further.

There were significant limitations associated with this study that suggest the results should be considered exploratory and not representative of all Australian orthopaedic surgeons. The survey was designed to be short, quick to complete, and comply with constrains of the free version of SurveyMonkey. Therefore, questions were limited to yes and no answers or predefined checkbox answers. This approach has been adopted in other surveys [17], but given the interest, it would have been advantageous to pretest orthopaedic surgeons for their opinion on terminology, the question design, and answer options. By doing this, we would have been more likely to produce more statistically relevant results. A more comprehensive study would also incorporate a survey of dental and general medical practitioners to compare or contrast the recommendations given to patients [16,17].

Surgeons and dentists in the United Kingdom, Canada, Australia, and the United States are following a variety of antibiotic prophylaxis guidelines led by what they believe is in their patients' best interest. This may result from individual surgeons not being aware of or up to date with current literature, suggesting more effort needs to be spent on dissemination of current best practice guidelines.

Conclusions

The lack of conclusive evidence linking PJI with dental treatment is a major barrier to surgeons adopting the guidelines and adjusting their practice. An individual's infection risk is far more immediate to a surgeon than the more distant and nebulous risk of antibiotic resistance. This suggests that surgeons will continue to prescribe antibiotic prophylaxis, which in their minds is avoiding putting their patients at risk of a PJI. Studies that track patients prospec- tively before and for several years after joint replacement surgery, maintaining records of PJI, proximity of development in relation to dental procedures, and use of antibiotics would be of great assistance to the profession to make decisive recommendations that benefit patients.

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6. The oral health study

Abstract

Background Oral health and regular dental attendance have a low priority, from patients and health professionals, in the context of the medical and social complexities associated with ageing, despite the negative impact oral and dental diseases can have on general health. The aim of this study was to describe the oral health status of hospitalised older people and determine whether general health characteristics can be used to indicate dental and oral health status. ***Methods*** A cross-sectional study conducted over a 12-month period in the Orthopaedic and Geriatric Management and Evaluation Unit (GEMU) wards at The Queen Elizabeth Hospital (TQEH). Discharge summaries and electronic records were used to collect patient data. Participants recruited for the oral health assessment (OHA) were given a clinical exam at the bedside and interviewed about their oral health and dental history. ***Results*** Seventy-three participants were recruited to the OHA group. An age and sex matched sample, who did not receive an OHA, were included for comparison of general health characteristics to assess for selection bias in the OHA sample (n=146). Thirty-nine (53.4%) of the OHA group had natural teeth, or a combination of teeth and dentures. The dentate participants were more likely to have admission polypharmacy (p=0.034), but there were no other differences based on dentition status. Fifty-six (76.7%) of participants required referral to the dentist. There were no specific medical conditions or general health characteristics that could be used to indicate a dental problem on admission to hospital. ***Conclusion*** The participants in this study had poor oral health, with three-quarters considered in need of a dentist. Given increasing life expectancy and the trend towards retention of natural teeth into older age, it is imperative that consideration is given to unique and innovative opportunities to address the oral health needs of older people.

6.1 Background

All aspects of oral health have the potential to impact on general health, and this is pertinent in the older population who live with medical complexity and are vulnerable to infection.[6] The mechanism of the oral and general health relationship is complex. In 2013 the United States (U.S.) Surgeon General[6(p164)] reported that dental problems are '*the 'silent X-factor' promoting the onset of life-threatening diseases which are responsible for the death of millions of American's each year.*'

The rate of edentulism, the complete loss of natural teeth, is decreasing with incremental tooth loss over the lifespan more common.[11,20] Increased natural tooth retention has resulted in increased coronal and root surface caries risk.[2,13] Untreated dental caries in permanent teeth was the most prevalent condition for the entire Global Burden of Disease (GBD) in 2010, across all ages.[99] Recent Australian studies in nursing homes have shown that people have an average of between 0.8 – 2.8 untreated decayed teeth.[2] Dental caries is a preventable condition and easily treated if detected early. Deep carious lesions can result in serious oral or systemic infection that can lead to hospitalisation, with Kruger and Tennant (2016) showing there has been an increase in hospitalisations for older people due to dental infections and their projections indicate a high burden of hospitalisation in the future.[3,78]

The prevalence and severity of periodontal disease increases with age.[5] It has been suggested that research over the past 20 years has underestimated periodontal disease due to significant tooth loss leading to the resolution of the disease.[13] Recent Australian studies have shown that nearly half of people aged 65 years and older have moderate to severe periodontal index scores.[5] Darby[5] highlights key periodontal-systemic interactions that are relevant in an ageing population; in particular diabetes mellitus, metabolic syndrome, obesity and osteoporosis.

Hyposalivation is very common in older people and can lead to poor quality of life by limiting food choices and making swallowing and talking difficult.[13] The cause of dry mouth

is complicated and is often associated with medication type, dosage or polypharmacy.[39] Reduced saliva increases a person's risk of oral disease, in particular dental caries and mucosal conditions.[4,13,39]

The loss of a functional dentition, whether it be natural teeth or well-fitting dentures, has been shown to be associated with poor oral intake and nutritional status and a decrease in oral-health-related quality of life.[2,4,53] The relationship between edentulism and general health is usually focused on nutritional status, assuming people with few or no functional teeth have difficulty eating a substantial and diverse diet.[55] However, a loss of teeth is also associated with a decrease in appetite and loss of taste, dysguesia.[45] The texture of food that a person can eat with dentures changes from crunchy to soft as chewing and breaking down food becomes more difficult without natural teeth.[55]

Frailty or being reliant on others for activities of daily living (ADLs) can result in inadequate daily oral hygiene homecare, increasing the bacterial load in the mouth.[6,34] Pneumonia is a leading cause of hospitalisation and death in older people, those with dementia and those living in residential care are most at risk.[6,100,101] Poor oral health has been identified as a risk factor for aspiration pneumonia as respiratory pathogens have been found in dental plaque.[102,103] Other medical conditions can also worsen in the presence of dental disease, particularly diabetes, cardiovascular disease and nutritional status.[5,6]

The 2012 Survey of Disability, Ageing and Carers (SDAC) found that only 51 percent of Australians aged 65 years and older had attended the dentist in the last 12 months.[1] There are many barriers to older people attending the dentist.[10,11,58] People from lower socio-economic backgrounds and with lower levels of education are less likely to seek regular dental care.[58] Physical and financial barriers can prevent older people from gaining access to dental care, particularly if they live in residential care facilities.[10] Nursing and care staff working in

RACFs often have a low leverl of oral health literacy and have difficulty caring for the daily oral health needs of their reisdents. [10]

Despite the increasing body of evidence of poor oral health in older people there has been little change in the dental delivery system.[4,12] Given the dental attendance patterns of older people are poor, it is vital that alternatives for dental review are investigated to ensure oral health problems are not leading to or increasing functional decline, morbidity or mortality.[4] Unfortunately, oral health is often overlooked during an acute hospital admission.[12,15] It has been suggested that poor oral health has the potential to become a new geriatric syndrome if oral health care is not incorporated into general health management.[51] The aim of this study is to establish whether general health characteristics such as medication use, medical comorbidities or in-hospital complications indicate the oral health state and need for dental referral.

6.2 Aim

The primary research aim: To describe the oral health of older people admitted to hospital; and discuss the association between poor oral health status as defined by dentition status or requiring dental assessment and health outcomes not limited to:

- Number and type of medical comorbidities
- Number and type of in-hospital complications
- Length of hospital stay
- Nutritional status
- Activities of daily living

6.3 Methods

As stated in detail in Chapter 4, this was a cross-sectional study conducted over a 12-month period (September 2013 – August 2014) at TQEH, participants were recruited from the Orthopedic ward and the Geriatric Evaluation and Management Unit (GEMU).

Again, selection bias in the sample was assessed by comparing participants with age and gender matched patients admitted during the same 12-month period. These are presented as the 'no oral health assessment group'.

The WHO Oral Health Survey: basic methods.[84] and recommendations made by Terezakis *et al*.[22] in their systematic review of the impact of hospitalization on oral health were used to develop the oral health assessment research protocol (Appendix 2). Admission characteristics including number of medical comorbidities, in-hospital complications and medication use were compared against the broad categories of dentition status (dentate and edentulous) and whether a dental referral was required.

General health measures

- Dementia assessment was made by the medical staff using the Mini-Mental State Examination (MMSE)[89] or the Rowland Universal Dementia Assessment Scale (RUDAS)[91] for non-English speaking patients.
- Nutritional status was assessment using the Mini-Nutritional Assessment-Short Form as this was already in use at the hospital.[93]
- Activities of Daily Living (ADLs) were measured using the Katz Index of ADLs.[92]

The full methods for this study are presented in Chapter 4.

6.3.1 Statistical analysis

Categorical measures were summarized as percentages with counts; Pearson's Chi-square test or Fisher's Exact test were used to assess group differences as appropriate. Continuous data were summarized using means with standard deviation and range. The Wilcoxon test was

used in lieu of the paired Student's T-test and the Mann Whitney U test in lieu of the t-test for independent samples to assess differences due to violations of normality. Length of stay, number of complications, number and type of comorbidity and number of discharge medications were treated as count variables and analysed using a negative binomial regression model to account for over-dispersion in the outcome variables. Univariate and multivariate logistic regression analyses were used to explore associations between predictor variables and binomial dependent variables and adjusted for age and sex. All tests were two-tailed and assessed at the 5% alpha level. The analyses were completed using SAS v9.4 (SAS Institute Inc., Cary, NC, USA) and SPSS v25.0 (IBM SPSS Statistics for Macintosh, Armonk NY: IBM Corp).

6.4 Results

6.4.1 General and dental characteristics

Seventy-three participants were recruited for the oral health assessment. Three-quarters (75.3%) were female, with a mean age of 84.4 years (SD 6.6). The dentition status and prevalence of dental conditions is presented in Table 6.1. Thirty-four (65.4%) participants had not visited a dentist for more than two years. Two-thirds (n=26, 68.4%) of participants who had not seen the dentist recently required dental referral. Most people (n=48, 65.8%) did not have a presenting dental complaint when asked. Eighteen (28.1%) patients reported difficulties with chewing and swallowing in the general interview, but when asked specifically about a chief dental complaint, only nine [of 18 respondents, 50%] reported the chewing and swallowing problems (p=0.1).

Thirty-nine (53.4%) of participants had natural teeth, or a combination of teeth and dentures. The average number of teeth was 16.6 [(SD 6.8) Range 3 – 26]. Four (5.5%) participants had no teeth and were not wearing replacement dentures. Three (8.8%) of the edentulous patients had retained roots, two of these were not wearing dentures. For one participant with full

dentures the retained root was the chief complaint and required immediate dental referral for extraction (Figure 6.1). The differences between dentate and edentulous participants with ill-fitting dentures were not significant (p=0.973). Although more dentate participants (n=18, 60.0%) had an oral mucosal condition, it was not significant (p=0.347).

Figure 6.1. An infected retained root in the upper left canine region.

6.4.2 The dentition

One-third of participants had a presenting dental complaint (n=24, 33.3%) (Table 6.1). Half of these (n=13, 54.2%) were dentate. The most common complaint was ill-fitting dentures, with three (7.7%) dentate participants unhappy with the fit of their partial dentures. The majority of dentate participants (n=35, 89.7%) had dental restorations (fillings) and it was deemed that 16 (45.7%) people had secondary decay around one or more of their restorations.

6.4.3 Dentition status

Table 6.2 shows the comparison between the dentate (with teeth) and edentulous (without teeth) participants. More edentulous participants (n=29, 85.3%) were female, but both groups were similar in age. Dentate participants (n=29/34, 85.3%) were more likely to be prescribed five or more medications daily (Age and sex adjusted OR 6.2, 95% CI 1.4-26.8, p=0.015). There were no other differences in general health characteristics based on dentition status.

6.4.4 Dental referrals

The general characteristics of the oral health assessment participants who were recommended referral to the dentist are presented in Table 6.3. As with the dentate/edentulous comparisons, admission polypharmacy was associated with a dental referral being recommended (n= 40, 81.6%, *p*=0.028, Fisher's Exact Test reported). Participants requiring a dental referral were three times more likely to consume five or more medications daily (OR=3.9, 95% CI 1.15-12.97, *p*=0.029). No other general health measure was associated with needing a dental referral.

Three quarters of the participants (n=56, 76.7%) were considered in need of a comprehensive examination with a dentist. Dental referrals were divided into two categories: urgent or general referral. Five (8.9%) patients required an emergency dental referral. Three participants had retained roots with associated infection, one participant had a large root fracture and the final patient had many dental problems, including extensive ulceration (Figure 6.2). Fifty-one (69.8%) participants required referral for general management including denture assessment and comprehensive dental examinations for caries management.

Photograph 1

Photograph 2

Figure 6.2. Two photographs of the same participant. Photograph 1 shows the unhealthy lower dentition and photograph 2 shows the edentulous maxilla with ulcerations

Table 6.1. Prevalence of dental characteristics [n=73, n (%)]

Dental Characteristic	n (%)
Last dental visit > 2 years ago (n=52)	34 (65.4)
Problems with chewing and swallowing (n=64)	18 (28.1)
Presenting dental complaint	24 (33.3)
Pain from natural teeth	3 (4.1)
Pain related to dentures	1 (1.4)
Loose or ill-fitting dentures	11 (15.0)
Dry mouth	6 (8.2)
Dentition status	
Natural teeth (no dentures)	20 (27.4)
Natural teeth and partial dentures	19 (26.0)
Full dentures	30 (41.1)
No dentures	4 (5.5)
Restored teeth	
Restored teeth, no obvious decay	35 (47.9)
Restored roots, no obvious decay	8 (11.0)
Dental decay	30 (41.1)
Root surface caries	15 (20.5)
Retained roots	10 (13.7)
Edentulous patients with retained roots	3 (8.8)
Basic Periodontal Exam score >1 (n=34)	19 (55.9)
Ill-fitting dentures	13 (17.8)
Dentate	7 (17.9)
Edentulous	6 (17.6)
Oral mucosal condition	30 (41.1)
Dentate	18 (60.0)
Edentulous	12 (40.0)
Self-reported or clinically detected dry mouth	13 (17.8)
Referral required	56 (76.7)

Table 6.2. The different general health characteristics based on dentition status, dentate or edentulous [Total n = 73, n (%), Mean ± SD].

Characteristic	Dentate n=39	Edentulous n=34	*P* value
Female	26 (66.7)	29 (85.3)	0.065
Age	83.7 ± 7.0	85.2 ± 6.2	0.229
Preadmission domicile	n=37	n=32	
Own Home	36 (97.3)	30 (93.8)	0.593
Residential care	1 (2.7)	2 (6.3)	
Reason for admission			
NOF	12 (30.8)	10 (29.4)	0.900
GEMU	27 (69.2)	24 (70.6)	
MMSE Score (24 or less)	n=17 10 (50.0)	n=14 7 (43.8)	0.709
Admission polypharmacy	**n=34 29 (85.3)**	**n=32 20 (62.5)**	**0.034**
Admission medications	8.7 ± 3.7	7.7 ± 5.3	0.167
Admission dry mouth medications	5.8 ± 2.4	5.2 ± 3.5	0.208
Discharge polypharmacy	n=34 33 (971)	n=32 28 (87.5)	0.190*
Discharge medications	11.3 ± 3.7	10.7 ± 4.2	0.380
Discharge dry mouth medications	6.7 ± 2.3	6.5 ± 2.8	0.964
Total length of stay (days)	27.7 ± 18.8	24.9 ± 15.3	0.592
Discharge location	n=37	n=33	
Own Home	20 (54.1)	16 (48.5)	0.642
Residential care	9 (24.3)	9 (24.3)	0.778
Rehab	4 (10.8)	6 (18.2)	0.499*
Other	4 (10.8)	2 (6.1)	0.677*
Death this admission	2 (5.1)	1 (2.9)	>0.999*

* Fisher's exact test

Table 6.3. General characteristics based on dental referral required or not required [Total n = 73, n (%), Mean ± SD].

Characteristic	Dental referral required n=56	Dental referral not required n=17	*P value*
Female	43 (76.8)	12 (70.6)	0.749*
Age	84.1 ± 6.9	84.1 ± 6.0	0.680
Preadmission domicile *Own Home* *Residential care*	 50 (96.2) 2 (3.8)	 16 (94.1) 1 (5.9)	 >0.999*
Reason for admission *NOF* *GEMU*	 16 (28.6) 40 (78.4)	 6 (31.6) 11 (68.4)	 0.597
MMSE Score (24 or less)	n=28 13 (46.4)	n=8 4 (50.0)	 >0.999*
Admission polypharmacy	**n=49 40 (81.6)**	**9 (52.9)**	**0.028***
Admission medications	8.4 ± 4.4	7.5 ± 5.0	0.358
Admission dry mouth medications	5.6 ± 2.8	5.3 ± 3.5	0.545
Discharge polypharmacy	n=49 46 (93.9)	15 (88.2)	0.597*
Discharge medications	11.2 ± 3.8	10.6 ± 4.5	0.288
Discharge dry mouth medications	6.8 ± 2.4	6.2 ± 2.8	0.513
Total length of stay (days)	25.4 ± 16.8	29.6 ± 18.5	0.524
Discharge location *Own Home* *Residential care* *Rehab* *Other*	n=53 28 (52.8) 14 (26.4) 7 (13.2) 4 (7.5)	 8 (47.1) 4 (23.5) 3 (17.6) 2 (11.8)	 0.679 >0.999* 0.696* 0.628*
Death this admission	3 (5.4)	0	>0.999*

* Fisher's exact test

6.4.5 Relationship between systemic and oral health

The association between medical comorbidities and dentition status is presented in Table 6.4. More edentulous participants had a previous cerebrovascular accident (CVA), (that was not their reason for admission), hypercholesterolaemia and hypertension, although there was no significant difference overall in diseases of the cardiovascular system. Ten (25.6%) dentate patients had cancer (all types, not including skin) compared to only one edentulous participant (p=0.008). With regards to the need for dental referral (Table 6.5) only conditions of the musculoskeletal system were significantly associated with the need for referral (p=0.016).

Nutrition

Oral health participants were considered 'at risk of malnutrition' with a mean Mini Nutritional Assessment-Short Form (MNA-SF) score of 9.3 ± 3.0 (range for at-risk in accordance with the assessment is 8-11).[93] Nutritional data was not available for the majority of 'no oral health assessment' participants and so comparisons could not be made. The differences in MNA-SF scores between patients who were dentate or required a dental referral are presented in Table 6.6.

Activities of daily living

Table 6.6 also contains the Katz Activities of Daily Living (ADLs) scores, which show a high level of independence prior to admission and a very low level of independence at the time of the assessment.[92] This score is out of six, closer to zero indicates a high level of dependence in terms of bathing, dressing, toileting, transferring, continence and feeding. Again, these were not available for the 'no oral health assessment' group.

In-hospital complications

No in-hospital complications were associated with dentition status. Although renal impairment or disease did produce a significant result, p=0.037 for requiring referral to the dentist, the numbers in each group are very small, five participants only (Tables 6.7 and 6.8). There were few associations between the significant medical health factors and individual dental factors and no individual dental problem was identified as having a relationship with medical heath factors (Table 6.9). There were some significant associations that cannot be generalised beyond these individual participants.

Table 6.4. The main medical comorbidities by dentition status, dentate or edentulous, Total n=73 [n (%), Mean ± SD].

Comorbidity	Dentate n=39	Edentulous n=34	*P* value
Number of comorbidities	7.6 ± 3.2	7.4 ± 3.8	0.530
Cardiovascular system	34 (87.2)	32 (94.1)	0.438*
CVA/TIA, Stroke	**3 (7.7)**	**9 (26.5)**	**0.031**
Hypercholesterolaemia	**14 (35.9)**	**20 (58.8)**	**0.050**
Hypertension	**21 (53.8)**	**29 (85.3)**	**0.004**
Ischaemic heart disease	11 (28.2)	9 (26.5)	0.868
Musculoskeletal system	20 (51.3)	20 (58.8)	0.518
Arthritis	10 (25.6)	14 (41.2)	0.159
Osteoporosis	8 (20.5)	9 (26.5)	0.548
Gastrointestinal system	17 (43.6)	13 (38.2)	0.643
Gastro-oesophageal reflux disorder	13 (33.3)	9 (26.5)	0.524
Respiratory system	16 (41.0)	7 (20.6)	0.061
Diabetes mellitus	11 (28.2)	9 (26.5)	0.868
Thyroid and parathyroid issues	9 (23.1)	7 (20.6)	0.798
Renal impairment or disease	7 (17.9)	6 (17.6)	0.973
Mental health	7 (17.9)	3 (8.8)	0.321*
Nervous system	6 (15.4)	4 (11.8)	0.742*
Cancer	**10 (25.6)**	**1 (2.9)**	**0.008**

* Fisher's exact test

Table 6.5. The medical comorbidities in terms of need for dental referral. Total n=73 [n (%), Mean ± SD].

Comorbidity	Dental referral required n=56	No Dental referral required N=17	*P* value
Number of comorbidities	7.6 ± 3.3	7.2 ± 4.2	0.268
Cardiovascular system	50 (89.3)	16 (94.1)	>0.999*
CVA/TIA, Stroke	9 (16.1)	3 (17.6)	>0.999*
Hypercholesterolaemia	25 (44.6)	9 (52.9)	0.548
Hypertension	39 (69.6)	11 (64.7)	0.701
Ischaemic heart disease	14 (25.0)	6 (35.3)	0.535
Musculoskeletal system	**35 (62.5)**	**5 (29.4)**	**0.016**
Arthritis	20 (35.7)	4 (23.5)	0.349
Osteoporosis	16 (28.6)	1 (5.9)	0.097*
Gastrointestinal system	25 (44.6)	5 (29.4)	0.264
Gastro-oesophageal reflux disorder	18 (32.1)	4 (23.5)	0.498
Respiratory system	19 (33.9)	4 (23.5)	0.419
Diabetes mellitus	16 (28.6)	4 (23.5)	0.766
Thyroid and parathyroid issues	13 (23.2)	3 (17.6)	0.748*
Kidney problems or disease	10 (17.9)	3 (17.6)	>0.999*
Mental health	9 (16.1)	1 (5.9)	0.435*
Nervous system	9 (16.1)	1 (5.9)	0.435*
Cancer	9 (16.1)	2 (11.8)	>0.999*

*Fisher's exact text

Table 6.6. The mini-nutritional assessment-short form and pre and post-activities of daily living (ADL) scores in terms of dentition status and need for referral (Mean ±SD).

Characteristic	Dentate	Edentulous	*P* value	Dental referral required	No dental referral required	*P* value
MNA-SF score	8.9 ± 2.9	9.7 ± 3.2	0.221	9.1 ± 3.0	9.9 ± 2.9	0.412
Katz ADL score (pre-admission)	5.6 ± 0.7	2.8 ± 1.9	0.350	5.4 ± 1.2	5.5 ± 0.9	0.797
Katz ADL score (during admission) [r]	5.1 ± 1.5	2.8 ± 2.1	0.932	2.9 ± 2.1	2.6 ± 1.7	0.726

[r] Wilcoxon signed rank test, p<0.001 in ADL scores from pre-admission to admission in all groups and categories.

Table 6.7. The most common in-hospital complications in terms of need for dentition status. Total n=72 [n (%), Mean ± SD].

In-hospital complication	Dentate n=38	Edentulous n=34	*P* value
Number of in-hospital complications	4.2 ± 3.1	5.0 ± 2.3	0.112
Frailty	19 (50.0)	16 (47.1)	0.803
Delirium	8 (21.1)	14 (41.2)	0.064
UTIs	12 (31.6)	12 (35.3)	0.738
Constipation	4 (10.5)	7 (20.6)	0.236
Falls	6 (15.8)	5 (14.7)	>0.999*
Anaemia	6 (15.8)	8 (23.5)	0.407
Pain	6 (15.8)	6 (17.6)	0.833
Cognitive decline or impairment	5 (14.7)	5 (13.2)	>0.999*
Renal impairment or disease	5 (14.7)	5 (13.2)	>0.999*

* Fisher's exact test

Table 6.8. The most common in-hospital complications in terms of need for dental referral required, Total n=72 [n (%), Mean ± SD].

In-hospital complication	Dental referral required n=56	No dental referral required n=16	*P* value
Number of in-hospital complications	4.5 ± 3.0	4.9 ± 1.6	0.354
Frailty	28 (50.0)	7 (48.8)	0.659
Delirium	14 (25.0)	8 (50.0)	0.070
UTIs	18 (32.1)	6 (37.5)	0.688
Constipation	9 (16.1)	2 (12.5)	>0.999*
Cognitive decline or impairment	7 (13.0)	3 (16.7)	0.703*
Falls	11 (19.6)	0	0.108*
Anaemia	12 (21.4)	2 (12.5)	0.721*
Pain	9 (16.1)	3 (18.8)	0.722
Renal impairment or disease	**5 (8.9)**	**5 (31.3)**	**0.037**

* Fisher's exact test

Table 6.9. The significant medical comorbidities and in-hospital complications in terms of the dental and oral mucosal conditions (n, %)

Characteristic	Last dental visit >2 years n=34	Chewing n=18	Reported a dental problem n=24	Oral mucosal n=30	Dental caries n=30	Root surface caries n=15	Retained roots n=12	BPE >1 n=19	Dry mouth n=13
Medications n=66									
Admission polypharmacy	n=30 20 (66.7)	n=18 14 (77.8)	n=23 **21 (91.3)**$^{\infty}$	n=24 20 (83.3)	n=26 20 (76.9)	n=14 11 (78.6)	n=11 9 (81.8)	n=24 13 (76.5)	n=10 8 (80.0)
Comorbidities n=73									
CVA/TIA/Stroke	7 (20.6)	2 (11.1)	4 (16.7)	5 (16.7)	3 (10.0)	3 (20.0)	2 (16.7)	2 (10.5)	2 (15.4)
Hypercholesterolaemia	**22 (64.7)**$^{\infty}$	10 (55.6)	13 (54.2)	14 (46.7)	13 (43.3)	5 (33.3)	7 (58.3)	8 (42.1)	8 (61.5)
Hypertension	24 (70.6)	14 (77.8)	18 (75.0)	22 (73.3)	**16 (53.3)**$^{\infty}$	7 (46.7)	8 (66.7)	11 (57.9)	9 (69.2)
Musculoskeletal system	20 (58.8)	13 (72.2)	13 (54.2)	14 (46.7)	14 (46.7)	8 (53.3)	7 (58.3	10 (52.6)	7 (53.8)
Cancer	6 (17.6)	1 (5.6)	3 (12.5)	6 (20.0)	**8 (26.7)**$^{\infty}$*	4 (26.7)	0	3 (15.8)-	2 (15.4)
Complications n=72									
Renal impairment or disease	6 (17.6)	2 (11.1)	3 (12.5)	6 (20.0)	4 (13.3)	2 (20.0)	2 (16.7)	2 (10.5)	3 (23.1)

$^{\infty}p < 0.05$ of significant association between those with the dental condition and those without
* Fisher's Exact Test reported

6.4.6 Differences between the assessment groups

There was no difference in terms of age and sex between the oral health assessment group and the no oral health assessment participants as they were a matched sample (Table 6.10). The mean number of daily medications increased for both groups from admission to discharge ($p<0.001$). The oral health assessment participants were similar in most general health characteristics to the non-oral health assessment group. However, they did differ in four key aspects: preadmission domicile ($p=0.01$), discharge medications ($p=0.041$), discharge medications with xerogenic potential ($p<0.001$) and total length of hospital stay in days ($p=0.024$). Multivariate analysis including all significant general characteristic variables revealed a statistical difference between the groups that remained significant when adjusted for age and sex [χ^2 (6, N=189) = 15.768, $p=0.015$]. The only variable independently significant in the model was the number of discharge medications ($p=0.028$).

Table 6.10. Comparison of the general health characteristics between the oral health assessment and no oral health assessment group [Total n = 219, n (%), Mean ± SD].

Characteristic	Oral health assessment n=73	No oral health assessment n=146	*P* value
Female	55 (75.3)	110 (75.3)	>0.999
Age	84.4 ± 6.6	84.5 ± 7.0	0.856
Preadmission domicile	**n = 69**	**n = 142**	
Own Home	**66 (95.7)**	**118 (83.1)**	**0.010**†
Residential care	**3 (4.3)**	**24 (16.9)**	
Reason for admission			
NOF	22 (30.1)	57 (39.0)	0.196
Falls	16 (21.9)	22 (15.1)	0.207
Delirium	8 (11.0)	20 (13.7)	0.567
Respiratory condition	7 (9.6)	7 (4.8)	0.240*
Other fracture	4 (5.5)	7 (4.8)	>0.999*
Comorbidities	7.5 ± 3.5	6.7 ± 3.0	0.290
In-hospital complications	4.6 ± 2.8	3.8 ± 2.6	0.052
Admission polypharmacy	49 (74.2)	86 (74.8)	0.936
Admission medications	8.2 ± 4.5	7.1 ±3.6	0.163
Admission dry mouth medications	5.5 ± 3.0	4.9 ± 2.6	0.218
Discharge polypharmacy	61 (92.4)	123 (94.6)	0.545
Discharge medicationsϒ	**11.0 ± 4.0**	**9.9 ± 3.7**	**0.041**
Discharge dry mouth medicationsϒ	**6.6 ± 2.5**	**5.5 ± 2.4**	**0.001**
Total length of stay (days)	**26.4 ± 17.2**	**22.0 ± 17.3**	**0.024**
Discharge location	n = 70	n = 141	
Own Home	36 (51.4)	72 (51.1)	0.960
Residential care	18 (25.7)	38 (27.0)	0.848
Rehab	10 (14.3)	22 (15.6)	0.802
Other	6 (8.6)	9 (6.4)	0.577*
Death this admission	3 (4.1)	5 (3.4)	0.799

* Fisher's Exact Test reported

† This is a p-value for 2 (Own home/RACF) by 2 (Oral health assessment Y/N) cross tabulation. Only one p-value exists

ϒ Wilcoxon Signed Rank Test – for comparisons in both groups between admission/discharge – all medications with xerogenic potential increased significantly, $p < 0.001$

6.5 Discussion

Poor oral health was common among participants in this study, with many having a potential source of oral infection in their mouth whether it be dental decay, periodontal disease or oral mucosal inflammation. The most serious source of infection was from retained roots, which led to three participants being recommended urgent dental referral. Many patients who were edentulous or wore partial dentures complained that they were ill-fitting. While no conclusive associations between oral health conditions and general health were established, the results are similar to other studies and indicate consideration for assessment and management of oral health in the older population is required.[31,42,55,71]

Despite the large number of participants not having seen the dentist for more than two years, many did have a presenting dental complaint that had not been recorded in their medical record. The finding in my study that three-quarters of participants needed to see a dentist for examination and treatment is consistent with a similar 2004 Western Australian study by Kruger *et al*.[79]

The dentition status (dentate or edentulous) was compared with general health characteristics as it is reported that patients with teeth are likely to be healthier, largely due to the ability to eat more nutritious and diverse food.[48,55,76,77] Oral health related quality of life (OHRQoL) is reportedly higher in people with their own natural teeth as they have higher self-esteem and community engagement because they are not ashamed of their appearance and inability to eat or talk.[20,55] No key differences were found in this study between dentate and edentulous patients. A larger sample size could be expected to reveal more valuable data with regards to this aspect.

The aim of this study was to determine whether general health characteristics could be used to identify patients most in need of a dental consult. However, it was not possible to categorise patients in terms of their dental treatment needs by their general characteristics,

medical comorbidities or in-hospital complications. It is difficult to identify dental risk factors because of the high level of comorbidity in the elderly people admitted to hospital. A 'universal precautions' approach when considering dental referral is potentially the safest, with all admitted patients screened for problems. However, given musculoskeletal (MSK) conditions were more common in patients who required a dental referral, priority could be given to patients with MSK conditions. This is particularly important if anti-resorptive medications are commenced considering the risk, albeit low, of medication-related osteonecrosis of the jaw (MRONJ).

Medical complexity is expected in acutely hospitalised older people and the impact of the hospitalisation is known to worsen their oral health.[22,104] Identification of dental and oral health problems earlier in a hospital admission could not only prevent worsening of general health as a result of poor oral health but could also result in patients being discharged with an oral health plan. The oral health plan could be incorporated into the discharge letter and give the general medical practitioner or Director of Nursing (DON), an indication of the state of the dentition and oral mucosa.

A multidisciplinary approach is considered vital in the successful management of older patients, to restore functional ability and avoid discharge to residential care.[70] The comprehensive geriatric assessment (CGA) is considered the 'gold standard' tool for ensuring all aspects of the patient's general health and well-being are managed.[70] A survey of older participants using the CGA in The Netherlands was comprehensive in terms of general health but the oral health question was – *do you have, or have you in the last month had pain in your mouth*.[105] Many dental problems are not painful until they are severe, particularly in the context of polypharmacy where pain is dulled and so a visual assessment is also necessary, not just a self-report.[4] A well-publicised CGA is the Australian developed interRAI series of geriatric assessments. There are no dental or oral health questions in the 56 clinical

observations in the interRAI Acute Care Comprehensive Geriatric Assessment.[16,106] All geriatric patients admitted to an acute care hospital should be considered in need of oral health assessments. Questions about the dentition status, recency of dental consult and presenting dental complaint should form part of the comprehensive geriatric assessment.

In terms of general health and well-being, the participants in this study presented similarly to other hospital-based studies, the majority had been living independently prior to this admission, had a high number of medical comorbidities and took more than five medications daily.[12,15,24] The number of daily medications increased at discharge, with half the daily medications having xerogenic potential.

Attempts were made to establish whether this sample of people who got the oral health assessment were representative of the broader older population, at least in terms of the patients admitted to this hospital. However, they differed in several key health areas. Oral health assessment participants were more likely to reside in their own home prior to admission. Based on what is known about oral and dental diseases in residential care, the oral health participants in this study could be considered to have oral health as good, or better, than the non-oral health group so the findings of this study should be considered valid. The results confirm that undiagnosed and untreated dental and oral health conditions are prevalent in community dwelling older people. This sector of the older population should be targeted for dental assessment before significant deterioration of general health or nursing home admission. Therefore, this is a good sample to demonstrate the scope of the problem and the risk of poor or worsening systemic health resulting from dental disease.

Oral health, in particular being free from pain, is important in the end stages of life but as this was the first dental study conducted in this hospital, geriatricians were conservative as they ultimately recommended the patients for recruitment and diverted the researchers away from

patients with a terminal condition, or from patients who were considered in need of palliative care.

Cardiovascular diseases were more prevalent in the edentulous participants; however, this was not a significant difference when considering whether a dental referral was required. The only general health category that was associated with dental referral was diseases or disorders of the musculoskeletal system. This is most likely due to the study recruiting participants in the orthopaedic ward, a third of the participants being admitted with a neck of femur fracture, and many others having osteoporosis and arthritis as comorbidities. Similarly, in-hospital complications were not associated with dentition status or the need to see a dentist.

While this study was unable to show a strong association between dental conditions and general health problems, it is known that there is a systemic relationship between dental and medical health and that the older population are the most vulnerable. Dental infection can lead to pain, increase symptoms associated with dementia and systemic infection in the extreme.[6,34] Poor oral hygiene results in an increased bacterial load, the amount of dental plaque in the mouth, which can be inhaled resulting in aspiration pneumonia.[7,22,107]

Unless the model of care changes significantly oral health practitioners are not likely to be employed in acute care hospitals.[59,60] The majority of older patients are assessed by a speech pathologist for swallowing capacity with a focus on oral intake to determine the ability to safely eat and swallow food.[9] The speech pathologist is the most qualified member of the allied health team, next to oral health practitioners, educated and experienced in assessing the structures of the mouth and throat. Yet, they rarely report on the dentition.[9] This is an opportunity missed, the speech pathologist can give nurses and physicians an indication of the health of the dentition and be educated in dental referral. There have been some recent studies exploring the use of the Oral Health Assessment Tool (OHAT) by speech

pathologists, and this is a key recommendation of this present study in terms of future research.[9,80]

6.6 Limitations

The limitations of this study, the sample size and the cross-sectional design have impacted on the ability to generalise the results to the broader population. The recruitment process, being led by geriatricians also exposes the study to sample bias, almost all oral health participants were living independently prior to this admission. Ultimately the oral health study patients presented with higher rates of admission polypharmacy they developed more in-hospital complications and had a longer stay in hospital. There isn't a suggestion that their oral health directly led to these problems, but it can't be ruled out as a contributing factor either.

A single dental clinician conducting the oral health assessment could also have led to measurement bias and limited the total number of patients that could be recruited. All photographs in this study were shown to a senior clinician and letters written to the patient's general medical practitioner for further assessment and follow up. The next stage of the project should incorporate a larger research team.

The small number of staff employed in the on-site dental department also limited the opportunity to obtain dental consults during short-term admissions. Patients with shorter LOS or those who live in RACFs could have their discharge delayed while waiting for a dental appointment which was not considered appropriate in the context of holding a bed for someone who by traditional measures, not including dental and oral health needs, was ready for discharge. This highlights the need to include some dental advice for the medical practitioners reviewing discharge summaries.

The lack of a follow-up oral health assessment makes it difficult to determine whether the oral health situation had worsened during the hospital admission and was able to improve following discharge. This would only have impacted on the periodontal condition and

perhaps the dryness of the mouth as dental caries, root surface caries and retained roots require time to develop and are unlikely to rapidly progress during an acute care hospital admission. A further assessment following discharge from hospital was planned however was unable to be conducted in the timeframe of the study.

This was an exploratory study and the first dental study conducted at this hospital. The lessons learned in implementing the project have resulted in a clear direction for future studies. Key pieces of information were missing from patient medical records that were expected to be available such as the MNA-SF and ADL scores. Future research projects could follow the cohort multiple randomised controlled trial (cmRCT) study design, where the baseline medical data is assumed and collected as part of standard care.[81,83] The dental data collection then becomes the focus of the study.

6.7 Conclusion

Detecting dental disease and infection is difficult and relies on an intra oral assessment to accurately assess patient needs. Dental practitioners are the ideal clinicians to perform this assessment, however nation-wide models of care need to change to facilitate employment of dentists, dental hygienists and oral health therapists in hospitals. In lieu of this, dental and oral health should form part of any comprehensive geriatric assessment. Utilisation of the allied health team, in particular speech pathologists, is necessary to ensure patients receive timely access to a dentist and avoid increased medical burden due to preventable dental infection.

Medications

The lack of standardised data collection from within the hospital, for example dementia assessments, delirium and frailty measures and pain scale data, and the small sample size made it difficult to identify how the oral health condition may be impacting on general health outcomes and vice versa. However, there was medication data available for the majority of participants. I therefore decided to assess whether there was any indication that medication use, specifically polypharmacy (the taking of five or more medications daily) was impacting on the dentition. This led to the consideration that perhaps medication use, and polypharmacy could be an indicator of more serious oral health problems.

Chapters 7 and 8 explore the issue of polypharmacy. Firstly, in Chapter 7, I look at the whole population and the general health differences between those with polypharmacy and those taking less than five medications daily. In Chapter 8, I focus on the oral health assessment participants and whether polypharmacy was an indicator of a need for referral to the dentist. It was my assumption that more unwell patients, those hospitalised for example, would consume more medications and I considered that these patients would be those most in need of referral to the dentist.

Finally, in Chapter 9, I explore the use of anti-resorptive medications commonly prescribed for osteoporosis and whether the patients taking these medications were referred for an oral health assessment as is recommended by international clinical guidelines. This aspect of the study was a consideration before the limitations imposed on the study sample given the research was conducted in an orthopaedic ward. It seemed valuable to continue with this part of the study, with the increased numbers of older people being prescribed anti-resorptive medication.

The clinical guidelines recommending dental referral have been established to prevent the very rare, but potentially debilitating condition of medication-related osteonecrosis of the jaw (MRONJ).

7. Polypharmacy

Abstract

Background Polypharmacy, taking five or more medications daily, is commonly associated with ageing. Medication rationalisation is recommended during an acute hospital admission, however oral and dental health are rarely considered as a factor. The aim of this study was to determine the prevalence of polypharmacy on admission to an acute care hospital and describe the health factors associated with polypharmacy.

Methods A cross-sectional study conducted over a 12-month period (September 2013 – August 2014) in the Orthopaedic and Geriatric Management and Evaluation Unit (GEMU) wards at The Queen Elizabeth Hospital (TQEH). Discharge summaries and electronic medical records were used to collect patient data. Medications were classified using the World Health Organisation (WHO) ATC/DDD coding system.

Results The total study sample was 219 participants, 73 (33.3%) participants were recruited to the oral health assessment group and an age and sex matched no oral assessment sample were included for comparison. Full medication data were available for 181 (82.6%) people. Admission polypharmacy was common (n=135, 74.6%) and the number of prescribed medications increased significantly at discharge ($p<0.001$). Admission polypharmacy was associated with an increased falls risk ($p=0.046$) There was no specific predictor for admission polypharmacy that would lead a physician to consider a whether a dental referral was necessary.

Conclusion An acute care hospital admission provides physicians and pharmacists with an opportunity to rationalise medication use to reduce the risk of adverse drug events. Incorporating dry mouth and other oral side-effects into the process will increase awareness of oral health issues associated with polypharmacy and facilitate timely dental referrals.

7.1 Background

The ageing population is living with multimorbidity requiring complex medication regimens often resulting in polypharmacy, consuming five or more medications daily.[51,108] Polypharmacy is not always a negative complication of ageing, as these medications can be vital for life.[109] However, medication related problems and adverse drug events (ADE) are a leading cause of hospitalisation for older adults.[110–112]

Medication rationalisation and deprescribing is aimed at safely reducing the number of medications patients take daily with the intention of limiting adverse drug events, cognitive impairment and hospitalisation.[113,114] Much of the literature promoting medication rationalisation suggests an acute hospital admission provides a convenient opportunity for physicians and pharmacists to re-evaluate patient's medication regimen with an aim to removing any unnecessary or non-life essential medication.[114] However, recent Australian and New Zealand audits indicate an acute hospital admission results in increased numbers of regularly administered medications rather than a reduction.[114] Dental or oral health is rarely reported as a consideration in the deprescribing or medication rationalisation literature, despite hyposalivation and xerostomia being common side effects of 500 individual medications and of polypharmacy.[115,116]

Xerostomia or hyposalivation may be caused by medical conditions such as Sjögren's syndrome or respiratory diseases such as: chronic obstructive pulmonary disorders (COPD), however, polypharmacy is the most common risk factor for a dry mouth.[39,43] The types of medications that can lead to xerostomia include but are not limited to: anticholinergics, diuretics, antihistamines and antineoplastics.[39] Impaired or reduced salivary flow has a negative impact on the dentition, increasing the risk of dental decay and infection and can lead to systemic complications associated with poor oral intake and nutrition.[47–49] Other common oral complications of polypharmacy include increased likelihood of oral mucosal infections such as candidiasis, difficult wearing dentures and burning sensations in the

mouth.[117] Most of these side-effects result from salivary disturbances. Self-esteem, social interaction and communication are also affected by hyposalivation in terms of oral health related quality of life (ORHQoL).[4,40]

The primary aim of this study was to determine the prevalence of polypharmacy and the number and type of xerogenic (dry mouth) potential medications older hospitalised people are taking. The secondary aim was to establish whether there are any general health characteristics or medical comorbidities are associated with polypharmacy.

7.2 Objectives

The objectives of this study were to:

1. Describe the prevalence of polypharmacy: consuming ≥ 5 medications daily on admission in a sample of hospitalised older people.
2. Identify admission medications with xerogenic (dry mouth) potential
3. Describe the type of medications participants were consuming on admission.
4. Describe the medical comorbidities associated with admission polypharmacy.

7.3 Methods

As outlined earlier this was a cross-sectional study conducted over a 12-month period (September 2013 – August 2014) at TQEH. Participants were recruited from the Orthopedic ward and the Geriatric Evaluation and Management Unit (GEMU). Again, selection bias in the sample was assessed by comparing participants with age and gender matched patients admitted during the same 12-month period. These are presented as the 'no oral health assessment group'. Discharge summaries and electronic medical records were used to collect basic medical data,

Comorbidities and complications were initially classified by anatomical system or medical category according to the International Statistical Classification of Diseases and Related

Health Problems (ICD-10.).[21] They were then further refined by the type of disease within the anatomical system.

Medications were classified according to the World Health Organisation (WHO) Collaborating Centre for Drug Statistics Methodology ATC/DDD system.[87] The medications were categorised at all five levels of the WHO system:

1. Anatomical main group,
2. Therapeutic subgroup,
3. Pharmacological subgroup,
4. Chemical subgroup,
5. Chemical substance.

Medication names were checked to identify any medication with dry mouth as an adverse reaction or side effect.

The detailed methods are described in Chapter 4.

7.3.1 Statistical methods

Categorical measures were summarized as percentages with counts; Pearson's Chi-square test or Fisher's Exact test were used to assess group differences as appropriate. Continuous data were summarized using means with standard deviation and range. The Wilcoxon test was used in lieu of the paired Student's T-test and the Mann Whitney U test in lieu of the t-test for independent samples to assess differences due to violations of normality. Logistic regression models were applied to assess residence in the community or an aged care facility on admission or discharge to own home, aged care or rehabilitation centre. The associations between admission polypharmacy and chief complaint, dentition status, dental referral and medical comorbidities were likewise assessed using logistic regression models and adjusted for age and sex. All tests were two-tailed and assessed at the 5% alpha level. The analyses were completed using SAS v9.4 (SAS Institute Inc., Cary, NC, USA) and SPSS v25.0 (IBM

SPSS Statistics for Macintosh, Armonk NY: IBM Corp). All tests were two-tailed and assessed at the 5% alpha level.

7.4 Results

Full admission medication data were available for 181 (82.6%) of the total study population.

7.4.1 Admission polypharmacy

The prevalence of admission polypharmacy in the total population with regards to general health characteristics is presented in Table 7.1. The majority of participants, (n=135, 74.6%) were consuming more than five medications daily. Reason for admission, categorised as neck of femur fracture (NOF) or general worsening of medical health (GEMU), was an independent predictor of admission polypharmacy (Age and sex adjusted OR 2.2, 95% CI = 1.1 - 4.5, p=0.031). Residential location on discharge was also associated with admission polypharmacy. More participants in the polypharmacy group (n=82, 61.2%) were discharged to their own home (p=0.013), while a greater proportion of people without polypharmacy on admission were discharge to residential care (n=17, 37.8% p=0.042). The physicians referred ten (7.4%) participants to the on-site dental department during their admission.

Table 7.2 shows the general health characteristics for participants with admission polypharmacy compared to those taking less than five medications daily. Consuming more than five medications daily was not significantly associated with an increased number of in-hospital complications or increased length of stay in the total study population. On admission 119 (91.5%) participants in the polypharmacy group resided in their own home, this reduced to 82 (61.2%) on discharge (Age and sex adjusted OR 2.3, CI 1.15-4.76, p=0.018).

7.4.2 Types of medications

Medications by WHO anatomical main group are presented in Table 7.3. Obviously the more common medication categories are aligned to common medical comorbidities, with more medications prescribed for conditions effecting the *Alimentary tract and metabolism*, the

Cardiovascular and *Nervous systems.* There was a significant difference between the polypharmacy groups in the consumption of medications in the *Systemic hormonal preparations, excl sex hormones and insulins* and *Musculoskeletal system* categories. Despite *Falls risk* being associated with admission polypharmacy, it was not associated with any of individual systemic medication categories.

Individual medications by WHO ATC/DDD group are presented in Table 7.4. The medications with xerogenic potential and with a statistically significant difference between the admission polypharmacy groups are identified in bold text. The most commonly prescribed medication on admission was acetylsalicylic acid (aspirin) (n=57, 31.5%). The diuretic frusemide was next most common medication [n = 44 (24.3%)]. Other medications commonly prescribed were lipid modifying agents, analgesics and proton pump inhibitors.

Table 7.1. The prevalence of participants taking ≥ 5 medications daily on admission with regards to general health characteristics [Total n = 181 (%)].

Characteristic	Polypharmacy n = 135	*P* value
Gender		
Female	101 (74.8)	0.863
Male	34 (25.2)	
Age		
65 – 84 years	67 (49.6)	0.833
85 years and older	68 (50.4)	
Admission ward		
Orthopaedic (NOF)	**33 (24.4)**	**0.029**
GEMU (general worsening of medical health)	**102 (75.6)**	
Preadmission domicile	n = 130	
Own Home	119 (91.5)	0.164*
RACF	11 (8.5)	
Comorbidities		
4 or less comorbidities	**14 (10.4)**	**<0.001**
5 or more comorbidities	**121 (89.6)**	
In-hospital complications		
2 or less in hospital complications	42 (31.3)	0.874
3 or more in hospital complications	92 (68.7)	
Physician referral to the dentist	10 (7.4)	>0.999*
LOS TQEH		
20 days or less	68 (50.4)	0.389
21 days or more	67 (49.6)	
Discharged to residential care	n = 134	
Yes	**30 (22.4)**	**0.042**
No	**104 (77.6)**	
Died, during hospital admission		
Yes	1 (0.7)	>0.999*
No	134 (99.3)	

* Fisher's Exact Test reported

Table 7.2. Characteristics of total population re polypharmacy at admission, n=181 [n (%), Mean ± SD].

Characteristic	Polypharmacy n=135	No polypharmacy n=46	*P* value
Female	101 (75.0)	35 (76.1)	0.863
Age	84.0 ± 6.2	84.6 ± 6.8	0.662
Preadmission domicile	n=130	n=44	
Own Home	119 (91.5)	37 (84.1)	0.164*†
Residential care	11 (8.5)	7 (15.9)	
Reason for admission			
NOF	**33 (24.4)**	**19 (41.3)**	**0.029**
Falls	28 (20.7)	9 (19.6)	0.864
Delirium	19 (14.1)	6 (13.0)	0.861
Respiratory condition	12 (8.9)	1 (2.2)	0.189*
Other fracture	9 (6.7)	2 (4.3)	0.732*
Comorbidities	**8.0 ± 3.1**	**5.1 ± 2.1**	**<0.001**
In-hospital complications	4.3 ± 2.7	3.9 ± 2.5	0.454
Admission medications	**9.1 ± 3.4**	**2.9 ± 1.2**	**<0.001**
Admission dry mouth medications	**6.1 ± 2.3**	**2.1 ± 1.2**	**<0.001**
Discharge medications	**11.6 ± 3.4**	**7.3 ± 2.6**	**<0.001**
Discharge dry mouth medications	**6.7 ± 2.2**	**4.0 ± 1.9**	**<0.001**
LOS TQEH	23.6 ± 14.6	24.4 ± 20.6	0.508
Discharge location	n=134	n=45	
Own Home	**82 (61.2)**	**18 (40.0)**	**0.013**
Residential care	**30 (22.4)**	**17 (37.8)**	**0.042**
Rehab	14 (10.4)	8 (17.8)	0.189
Other	8 (6.0)	2 (4.4)	>0.999*
Death this admission	1 (0.7)	1 (2.2)	0.445

***** Fisher's Exact Test reported

† This is a p-value for 2 (Own home/RACF) by 2 (Oral health assessment Y/N) cross tabulation. Only one p-value exists

Table 7.3. List of medications by WHO Anatomical main group by admission polypharmacy Y or N (n=181)

Medication subgroup	Polypharmacy n=135	No polypharmacy n= 46	*P* value
Alimentary tract and metabolism	**117 (86.7)**	**18 (39.1)**	**<0.001**
Blood and blood forming agents	**99 (73.3)**	**11 (23.9)**	**<0.001**
Cardiovascular system	**126 (93.3)**	**27 (58.7)**	**<0.001**
Dermatologicals	3 (2.2)	2 (4.3)	0.602*
Genitourinary system and sex hormones	10 (7.4)	0	0.067*
Systemic hormonal preparations, excl sex hormones and insulins	**34 (25.3)**	**4 (8.7)**	**0.018**
Antiinfectives for systemic use	15 (11.1)	1 (2.2)	0.075
Antineoplastic and immunomodulating agents	7 (5.2)	0	0.194
Musculo-skeletal system	**49 (36.3)**	**4 (8.7)**	**<0.001**
Nervous system	**107 (79.3)**	**21 (45.7)**	**<0.001**
Other Medications	1 (0.7)	1 (2.2)	0.445*
Antiparasitic products, insecticides and repellents	0	0	-
Respiratory system	**30 (22.2)**	**1 (2.2)**	**0.002**
Sensory organs	21 (15.6)	3 (6.5)	0.119
Various	1 (0.7)	0	>0.999*

* Fisher's Exact Test reported

Table 7.4. Common admission medications being taken by 10 or more people, categorised by WHO ATC/DDD. Medications with xerogenic potential highlighted in bold [Total n = 181]

Anatomical main group	Therapeutic subgroup	Chemical subgroup	Medication name	Polypharmacy n = 135	No polypharmacy n = 46	*P* value
Alimentary tract and metabolism	**Drugs for acid related disorders**	**Proton pump inhibitors**	**Pantoprazole**	**31 (23.0)**	**4 (8.7)**	**0.034**
		Proton pump inhibitors	**Esomeprazole**	**23 (17.0)**	**0**	**0.003**
	Drugs for constipation	Softener, emollients	Docusate sodium	22 (16.3)	4 (8.7)	0.204
		Osmotically acting laxatives	Movicol	10 (7.4)	1 (2.2)	0.294*
		Biguanides	Metformin	17 (12.6)	3 (6.5)	0.257
		Sulfonylureas	Gliclazide	10 (7.4)	0	0.067*
	Mineral supplements	Vitamin D and analogues	Cholecalciferol	37 (27.4)	1 (2.2)	<0.001
		Calcium	Calcium carbonate	16 (11.9)	1 (2.2)	0.076*
		Calcium, combinations with vitamin D and/or other drugs	Calcium/Cholecalciferol	25 (18.5)	3 (6.5)	0.052
Blood and blood forming agents	**Antithrombotic agents**	Vitamin K antagonists	Warfarin	17 (12.6)	0	0.007*
		Platelet aggregation inhibitors excl. heparin	Clopidogrel	14 (10.4)	2 (4.3)	0.366*
		Platelet aggregation inhibitors excl. heparin	**Acetylsalicylic Acid**	**51 (37.8)**	**6 (13.0)**	**0.002**
	Antianemic preparations	Iron in combination with folic acid	Ferrous fumarate and other iron supplements	16 (11.9)	1 (2.2)	0.076*

Table 7.4 continued

Anatomical main group	Therapeutic subgroup	Chemical subgroup	Medication name	Polypharmacy n = 135	No polypharmacy n = 46	*P* value
Cardiovascular system	Cardiac therapy	Digitalis glycosides	Digoxin	15 (11.1)	2 (4.3)	0.246*
		Organic nitrates	Glyceryl trinitrate	10 (7.4)	0	0.067*
		Organic nitrates	**Isosorbide mononitrate**	**18 (13.3)**	**0**	**0.008***
	Diuretics	**Sulfonamides, plain**	**Frusemide**	**40 (29.6)**	**4 (8.7)**	**0.004**
	Beta blocking agents	Beta blocking agents, selective	Metoprolol/ metaprolol tartrate	12 (8.9)	1 (2.2)	0.189
		Beta blocking agents, selective	Atenolol	18 (13.3)	2 (4.3)	0.093
	Calcium channel blockers	Dihydropyridine	Amlodipine	10 (7.4)	1 (2.2)	0.294*
	Agents acting on the renin-angiotensin system	ACE Inhibitors and calcium channel blockers	Peridopril arginine - amlodipine	20 (14.8)	3 (6.5)	0.145
	Lipid modifying agents	HMG CoA reductase inhibitors	Simvastatin	16 (11.9)	3 (6.5)	0.410*
		HMG CoA reductase inhibitors	Atorvastatin	36 (26.7)	4 (8.7)	0.011
		HMG CoA reductase inhibitors	Rosuvastatin	17 (12.6)	5 (10.9)	0.757
Systemic hormonal preparations, excl sex hormones and insulins	Thyroid therapy	Thyroid hormones	Thyroxine	24 (17.8)	4 (8.7)	0.141
Musculo-skeletal system	Antigout preparations	Preparations inhibiting uric acid production	Allopurinal	10 (7.4)	1 (2.2)	0.294*
	Drugs for treatment of bone diseases	Bisphosphonates	Aledronate and Aledronate combi	10 (7.4)	1 (2.2)	0.294*
			Risedronic acid and Risedronic acid combi	15 (11.1)	0	0.013*

Table 7.4 continued

Anatomical main group	Therapeutic subgroup	Chemical subgroup	Medication name	Polypharmacy n = 135	No polypharmacy n = 46	*P* value
Nervous system	Analgesics	Oripavine derivatives	Buprenorphine	10 (7.4)	0	0.067*
		Anilides	Paracetamol osteo	24 (17.8)	2 (4.3)	0.025
		Anilides	Paracetamol	34 (25.2)	9 (19.6)	0.439
	Antiepileptics	Carboxamide derivatives	Carbamazepine	8 (5.9)	0	0.205*
		Other antiepileptics	Pregabalin	10 (7.4)	1 (2.2)	0.294*
	Anti-Parkinson drugs	Dopa and dopa derivatives	Levodopa/carbidopa	11 (8.1)	0	0.068*
	Psychoanaleptics	Selective serotonin reuptake inhibitors	Citalopram	10 (7.4)	0	0.067*
Respiratory system	Drugs for obstructive airway diseases	Selective beta-2 andrenoreceptor agonists	Salbutamol	17 (12.6)	0	0.007*
		Adrenergics in combination with corticosteroids or other drugs, excl. anticholinergics	Fluticasone/salmeterol inhaler	14 (10.4)	1 (2.2)	0.120*
		Anticholinergics	Tiotropium	11 (8.1)	0	0.068*
Sensory organs	Ophthalmologicals	Prostaglandin analogues 1)	Latanoprost	8 (5.9)	1 (2.2)	0.452

* Fisher's Exact Test reported

7.4.3 Systemic health and medication use

The medical comorbidities by system and the main individual comorbidities are presented in Table 7.5. The most common medical conditions by ICD-10 classification were *Diseases of the cardiovascular system, the musculoskeletal system and the digestive system*. There were significantly more participants with admission polypharmacy who had *Diseases of the cardiovascular and digestive systems* (both $p < 0.001$). The patients admitted to the Orthopaedic ward for a NOF fracture had fewer medical comorbidities [Mean 6.0 (SD 3.1)] compared to the GEMU admissions for worsening of general health ($p < 0.001$). The NOF fracture patients were also consuming less medications [Mean 6.3 (SD 3.5)] than the GEMU patients [Mean 8.0 (SD4.1)] ($p = 0.006$). At discharge, the number of daily medications was even between the NOF and GEMU admissions, with patients taking an average of 10 medications daily (p=0.781).

Participants consuming five or more medications daily were living with a significantly higher number of medical comorbidities [Mean 8.0 (SD 3.1), $p < 0.001$]. Cardiovascular diseases were the most common in both groups and significantly more in the admission polypharmacy group (n=123, 91.1%, p=0.001). Hypertension was the most common cardiovascular disease but there was no difference between the groups in terms of polypharmacy (p=0.127).

Falls risk was associated with admission polypharmacy in the Chi-square test but was not a statistically significant individual predictor of admission polypharmacy (p=0.066). This result is likely to have been impacted by the small sample size. The other comorbidities, or groups of conditions, were significant and remained so after adjusting for age and sex.

Multivariate analysis was then conducted using all the significant predictors from the Chi-square analysis (Table 7.6). The full model containing all predictors was statistically significant, [χ^2 (8, n=181) = 37.280, $p < 0.001$], indicating the model was able to distinguish between people with admission polypharmacy and those without. Gastrointestinal system

disorders (p=0.02), hypercholesterolaemia (p=0.01) and renal impairment or disease (p=0.05) made uniquely significant contributions to the model with high cholesterol being the strongest predictor with an odds ratio of 3.227 (95% CI 1.3 – 7.8). Gastrointestinal disorders and kidney disorders were also strong predictors, but the 95% confidence intervals for both these categories were very large, indicating that sample size was too small.

Table 7.5. The main medical comorbidities by admission polypharmacy n=181 [n (%), Mean ± SD].

Comorbidity	Polypharmacy n=135	No polypharmacy n=46	*P* value
Number of comorbidities	**8.0 ± 3.1**	**5.1 ± 2.1**	**<0.001**
Cardiovascular system	**123 (91.1)**	**33 (71.7)**	**0.001**
Atrial fibrillation	20 (14.8)	7 (15.2)	0.947
Cerebrovascular disease	20 (14.8)	4 (8.7)	0.291
Hypercholesterolaemia	**64 (47.4)**	**10 (21.7)**	**0.002**
Hypertension	93 (68.9)	26 (56.5)	0.127
Ischaemic heart disease	31 (23.0)	8 (17.4)	0.427
Musculoskeletal system	81 (60.0)	29 (63.0)	0.715
Arthritis	44 (32.6)	20 (43.5)	0.182
Osteoporosis	35 (25.9)	12 (26.2)	0.983
Digestive system	**61 (45.2)**	**8 (17.4)**	**0.001**
Diverticular disease	11 (8.1)	4 (8.7)	0.907
Gastro-oesophageal reflux disorder	44 (32.6)	5 (10.9)	0.004
Respiratory system	**39 (28.9)**	**6 (13.0)**	**0.032**
Asthma	16 (11.9)	2 (4.3)	0.167*
Chronic obstructive pulmonary disease	12 (8.9)	2 (4.3)	0.523*
Other respiratory conditions	24 (17.8)	3 (6.5)	0.064
Diabetes mellitus	38 (28.1)	7 (15.2)	0.080
Genitourinary system	29 (21.5)	9 (19.6)	0.783
Urinary tract infections	17 (12.6)	3 (6.5)	0.257
Mental health	26 (19.3)	6 (13.0)	0.340
Thyroid and parathyroid issues	25 (18.5)	5 (10.9)	0.228
Renal impairment or disease	**25 (18.5)**	**2 (4.3)**	**0.020**
Renal impairment or failure	16 (11.9)	1 (2.2)	0.076*
Nervous system	23 (17.0)	3 (6.5)	0.079
Neurology	12 (8.9)	2 (4.3)	0.523*
Parkinson's disease	10 (7.4)	1 (2.2)	0.294*
Dementia	20 (14.8)	11 (23.9)	0.157
Cancer	20 (14.8)	4 (8.7)	0.291
Vision impairment	18 (13.3)	6 (13.0)	0.960
Falls	**17 (12.6)**	**1 (2.2)**	**0.046***

* Fisher's Exact Test reported

Table 7.6. Multivariate model includes factors that were significantly associated with admission polypharmacy on univariate analysis

	OR	95% CI		*P value*
		Lower	Upper	
Age	0.983	0.926	1.043	0.573
Sex	0.978	0.404	2.369	0.960
Cardiovascular	2.493	0.905	6.868	0.077
Hypercholesterolaemia	3.227	1.331	7.827	0.010
Gastrointestinal	5.306	1.302	21.625	0.020
Gastro-oesophageal reflux disorder	0.833	0.161	4.309	0.828
Respiratory	2.559	0.901	7.270	0.078
Renal impairment or disease	4.810	0.998	23.192	0.050

7.5 Discussion

Admission polypharmacy was common among the participants in this study and medication use increased during the hospital admission so that by discharge the majority of participants were prescribed more than five daily medications. The participants in this small study are consistent in terms of medical comorbidities and medication use to those reviewed in a large retrospective cohort study that assessed risk factors for readmission to hospital following and acute care admission.[118] Polypharmacy, significant worsening in functional status and length of acute hospital stay were important risk factors for readmission. They also noted that many older patients are prescribed proton pump inhibitors during admission and that continuing these following discharge places them at risk of pneumonia and clostridium difficile infection.[118] The number of patients taking pantoprazole doubled from admission to discharge in our study.

Polypharmacy has been identified as one of the most prevalent geriatric conditions that can lead to adverse drug events, in particular falls, and rehospitalisation.[105,119,120] Falls are a

significant burden with considerable morbidity and mortality and are the fifth leading cause of death in older adults in the United Kingdom (U.K.).[121] In Australia, one in every ten days spent in hospital by an older person is falls related.[14] The finding of this present study that admission polypharmacy was associated with falls is consistent with the research. The concern is that upon discharge the number of participants with polypharmacy increased significantly, thereby potentially increasing the risk of future falls and re-hospitalisation, or worse death.

Patients with admission polypharmacy had more medical comorbidities and were more likely to be discharged back to their own home, where based on current Australian data they are unlikely to seek out dental care.[1,19] Twenty percent of the patients with admission polypharmacy and 40 percent of the no polypharmacy group were discharged to residential aged care. This is not unexpected as many as 30 percent of acute care admissions result in a transition to residential care.[12,122]

7.5.1 Potential oral health implications

As described in Chapter 2 the majority of geriatric dental and oral health research has been conducted in nursing homes. It is known that the oral health of institutionalised older people is poor and deteriorates rapidly following admission. It is also common for older people in residential care to consume nine or more medications daily.[4] Given these facts, utilisation of an on-site hospital dental department should be considered a routine part of care for older patients who are to be discharged to residential care. In our study medications known to be risk factors for xerostomia increased during the hospital admission and yet less than 10 percent of the total study sample were reviewed by a dentist during their admission. This highlights the importance of increasing the awareness among the medical and allied health professions of the association between medical and dental health. Consideration of automatic dental referral for patients with polypharmacy, extended questioning in the comprehensive

geriatric assessment, beyond dentition type or pain, and an intra-oral assessment for oral cleanliness should all be considered as part of an acute hospital admission especially when there is a dental unit on-site. In situations where there is no dentist on-site, the discharge summary should incorporate instructions to the general medical practitioner to facilitate pathways to timely dental care.

7.6 Limitations

The results of this study are limited by the single-site research setting and the small sample size reducing the potential to make assumptions about the broader older population. This is the first Australian study to attempt to research the impact of polypharmacy on oral health in the acute hospital setting, but there is a need to improve the study design in order to extend the results to the whole older adult population.[40]

It is also considered a disadvantage that only the types of medications consumed were recorded. There is potential for further research of the specific daily dose and frequency of medications including their impact on different aspects of general health.

A lack of follow-up review following discharge is also a limitation that could have highlighted any temporary change to the medication regimen, or identified patients readmitted to hospital due to an adverse drug event.

Thomson (2015) discusses the difficulties associated with researching polypharmacy in older people and suggests that researchers should consider the number of medications, the type and the combination in order to determine the impact on oral health. Wimmer *et al*.,[110,123] have recently published studies investigating medical complexity on hospital readmission and all-cause mortality. There is scope to apply features of their study design to an oral health medication complexity study.

7.7 Conclusion

An acute care hospital admission provides physicians and pharmacists with an opportunity to rationalise medication use to reduce the risk of adverse drug events. Incorporating dry mouth into the medication rationalisation and deprescribing research will increase awareness of oral health issues associated with polypharmacy and facilitate timely dental referrals. Physicians, and pharmacists should consider polypharmacy and the type of medications patients are consuming and recommend a dental referral whenever dental side-effects are suspected.

8. Polypharmacy and oral health

Abstract

Background There is minimal consideration of dental and oral health problems associated with polypharmacy outside of the dental literature, despite the significant impacts on general health resulting from dental infection. Salivary changes that lead to increased dental disease risk are not directly related to ageing but are more likely to be the result of medication use, in particular polypharmacy, taking five or more medications daily. The aim of this study was to investigate the relationship between polypharmacy and oral health in a population of hospitalised older people. ***Methods*** Participants were recruited from the Orthopaedic and GEMU wards at The Queen Elizabeth Hospital, Adelaide South Australia. Medications were classified using the World Health Organisation (WHO) ATC/DDD coding system. The WHO Oral Health Survey: basic methods was used to collect dental data. Participants were asked a series of questions about their oral health and dental history. ***Results*** Medication data were available for 66 (90.4%) participants. Polypharmacy at admission was common (n=49, 74.2%) but it was not associated with any particular dental disease. More half the participants (57%) had not seen a dentist in the last two years. Ten (13.7%) participants had xerostomia. Three-quarters (71.2%) needed referral to the dentist. ***Conclusion*** Dental diseases were common, and the majority of people required a dental consult, but no particular medical health characteristics were found to identify patients more in need of a dental referral. Oral health should be considered when deprescribing or rationalising medication regimens given the impact dental diseases can have on systemic health.

8.1 Background

Polypharmacy, taking five or more medications daily, has serious implications for older people who are at increased risk of frailty, falls, hospitalisation and mortality associated with an adverse drug event (ADE).[88,112] The most common oral complication of polypharmacy is xerostomia, the sensation of having a dry mouth.[116] Anticholinergics, amphetamines, antidepressants, antihistamines, diuretics and antihypertensives are medications are known to have a xerostomic effect on saliva.[124]

Xerostomia leads to the worsening of many dental conditions including dental caries (decay), periodontal disease and oral mucosal infections.[40,117] Burning mouth sensation and an inability to wear dentures due to friction and a lack of suction are commonly reported in older patients with xerostomia.[36,43,116]

Polypharmacy is often avoided in dental research due to the complexity of determining whether an individual medication, or the combination of medications is responsible for the salivary change.[40] Respiratory conditions, such as emphysema, often lead to mouth breathing which results in oral dryness.[40] Alzheimer's disease, rheumatoid arthritis and nutritional deficiencies are also known to cause degenerative changes in the salivary glands.[119] However, salivary changes are not always associated with ageing but rather with medical or medication complexity.[2,40,117]

There are also general health complications that result from changes to the quality and quantity of saliva. Food choices are impacted, with people avoiding crunchy, fibrous or sticky foods as they are difficult to swallow.[37] Nutritional status may also be affected as dentures become unwearable. A lack of saliva can also result in taste disturbances, lessening the satisfaction gained from eating interesting or more diverse foods.[45,125]

The relationship between general and oral health is complicated and extends beyond a systemic association. Poor oral health, and in particular xerostomia, can have a negative

impact on social aspects of quality of life.[125] The rapid breakdown of the dentition in the absence of healthy saliva can lead to infection and pain. Speaking and communicating is altered in the absence of saliva which can lead to a reduction in self-esteem and contribute to isolation.[6,33]

A survey of New Zealand (NZ) dentists who participated in the New Zealand Older People's Oral Health Survey (NZOPOHS) found that they felt inadequately prepared to manage the significant dental problems that are becoming commonplace in light of the retention of the natural dentition.[56] Other avenues need to be explored to enable older adults to get an oral health assessment and reduce the barriers to accessing traditional dental services. Some of the respondents to the dentist survey that accompanied the NZOPOHS study suggested increasing awareness of the oral implications of polypharmacy and medical comorbidities.[56]

A common theme developing throughout this thesis is the potential for an acute hospital admission to be used to gain valuable information on the oral health of otherwise symptomatic dental attenders and facilitate access to dental treatment.

The aim of this study was to investigate whether medication use impacts on the oral health of older inpatients, and whether it is possible to predict dental disease based on admission polypharmacy or the types of medications prescribed.

8.2 Objectives

The objectives of this study were to:

1. Describe the prevalence of polypharmacy in a sample of hospitalised older people.
2. Identify the medications with xerogenic (dry mouth) potential
3. Describe the relationship between oral and dental health characteristics and polypharmacy
4. Describe whether admission polypharmacy and type of medical comorbidities can indicate the need for a dental referral.

8.3 Methods

As outlined earlier this was a cross-sectional study conducted over a 12-month period (September 2013 – August 2014) at TQEH. Participants were recruited from the Orthopedic ward and the Geriatric Evaluation and Management Unit (GEMU). Again, selection bias in the sample was assessed by comparing participants with age and gender matched patients admitted during the same 12-month period. These are presented as the 'no oral health assessment group'. Discharge summaries and electronic medical records were used to collect basic medical data,

Comorbidities and complications were initially classified by anatomical system or medical category according to the International Statistical Classification of Diseases and Related Health Problems (ICD-10.).[21] They were then further refined by the type of disease within the anatomical system.

Medications were classified according to the World Health Organisation (WHO) Collaborating Centre for Drug Statistics Methodology ATC/DDD system.[87] The medications were categorised at all five levels of the WHO system:

1. Anatomical main group,
2. Therapeutic subgroup,
3. Pharmacological subgroup,
4. Chemical subgroup,
5. Chemical substance.

Medication names were checked to identify any medication with dry mouth as an adverse reaction or side effect.

The detailed methods are described in Chapter 4.

8.3.1 Statistical methods

Categorical measures were summarized as percentages with counts; Pearson's Chi-square test or Fisher's Exact test were used to assess group differences as appropriate. Continuous data were summarized using means with standard deviation and range. The Wilcoxon test was used in lieu of the paired Student's T-test and the Mann Whitney U test in lieu of the t-test for independent samples to assess differences due to violations of normality. Logistic regression models were applied to assess residence in the community or an aged care facility on admission or discharge to own home, aged care or rehabilitation centre. The associations between admission polypharmacy and chief complaint, dentition and dental referral were likewise assessed using logistic regression models and adjusted for age and sex. The analyses were completed using SAS v9.4 (SAS Institute Inc., Cary, NC, USA) and SPSS v25.0 (IBM SPSS Statistics for Macintosh, Armonk NY: IBM Corp). All tests were two-tailed and assessed at the 5% alpha level.

8.4 Results

8.4.1 General characteristics

Full admission medication was available for 66 (90.4%) of the oral health assessment participants. The prevalence of admission polypharmacy in the oral health assessment group is presented in Table 8.1. The majority of participants (n=45, 91.8%) with polypharmacy had five or more medical comorbidities ($p = 0.001$). The number of in-hospital complications when dichotomised (≤2 or ≥3 complications) were associated with admission polypharmacy ($p = 0.026$) however, the mean number of complications was not significantly different between the oral health assessment participants with polypharmacy and those without (Table 8.2).

There was a significant increase in the number of medications consumed at discharge compared to admission, regardless of whether the participant had polypharmacy on

admission. At discharge 61 (92.4%) of the 66 participants with available medication data were consuming five more medications daily.

8.4.2 Type of medications by the WHO Anatomical main-group

The type of medications taken by participants at admission is presented in Table 8.3. There were significantly more participants with polypharmacy consuming medications from the *Alimentary tract and metabolism (p* <0.001*), Blood and blood forming agents (p* <0.001*), Musculo-skeletal system (p* <0.020*), and Nervous systems* medication categories *(p* <0.001). Due to the small numbers of participants consuming these medications on discharge, further analysis to determine predictors of polypharmacy did not produce meaningful results.

8.4.3 Medications with xerogenic potential

The breakdown of medications by name are presented in Table 8.4. There are few significant differences between the polypharmacy groups with pantoprazole (p =0.051) and frusemide (p= 0.054) just over the standard value of $p < 0.05$ normally accepted for statistical significance. Both of these medications have xerogenic potential. For the remaining medications, either similar proportions of people within each group were consuming the medication or too few people were consuming the medication to produce consequential results.

Table 8.1. The prevalence of oral health assessment participants with admission polypharmacy with regards to general health characteristics [Total n = 66].

Characteristic	Polypharmacy n (%)	*P* value
Gender		
Female	39 (79.6)	0.324
Male	10 (20.4)	
Age		
65 – 84 years	25 (51.0)	0.579
85 years and older	24 (49.0)	
Reason for admission		
NOF	12 (24.5)	0.752*
GEMU	37 (75.5)	
Preadmission domicile	n=46	
Own Home	46 (100.0)	0.070*
RACF	0	
Comorbidities		
4 or less comorbidities	**4 (8.2)**	**0.001***
5 or more comorbidities	**45 (91.8)**	
In-hospital complications		
2 or less in hospital complications	**17 (35.4)**	**0.026***
3 or more in hospital complications	**31 (64.6)**	
LOS TQEH		
20 days or less	20 (40.8)	0.281
21 days or more	29 (59.2)	
Discharged to RACF		
Yes	11 (22.4)	0.514*
No	38 (77.6)	
Died, during hospital admission		
Yes	0	0.258*
No	49 (100)	

* Fisher's exact test

Table 8.2. General characteristics of the oral health assessment participants by admission polypharmacy, n=66 [n (%), Mean ± SD].

Characteristic	Polypharmacy n=49	No polypharmacy n=17	*P* value
Female	39 (79.6)	11 (64.7)	0.324*
Age	83.6 ± 6.5	83.8 ± 5.9	0.633
Preadmission domicile	n = 46		
Own Home	46 (100.0)	15 (88.2)	0.070*
Residential care	0	2 (12.5)	
Reason for admission			
NOF	12 (24.5)	5 (29.4)	0.752*
Falls	11 (22.4)	5 (29.4)	0.743*
Delirium	6 (12.2)	2 (11.8)	>0.999*
Respiratory condition	5 (10.2)	1 (5.9)	>0.999*
Other fracture	3 (6.1)	1 (5.9)	>0.999*
Multimorbidities	**8.4 ± 3.6**	**5.2 ± 2.0**	**<0.001**
In-hospital complications	4.2 ± 2.8	4.8 ±2.1	0.336
Admission medications	**10.0 ± 3.8**	**3.0 ± 1.2**	**<0.001**
Admission dry mouth medications[γ]	**6.6 ± 2.6**	**2.3 ± 1.2**	**<0.001**
Discharge medications[†]	**12.1 ± 3.6**	**7.6 ± 3.1**	**<0.001**
Discharge dry mouth medications	**7.2 ± 2.2**	**4.6 ± 2.4**	**<0.001**
LOS TQEH	27.1 ± 16.5	26.1 ± 19.4	0.512
Discharge location			
Own Home	29 (59.2)	6 (37.5)	0.131
Residential care	11 (22.4)	5 (31.3)	0.514*
Rehab	5 (10.2)	4 (25.0)	0.207*
Other	4 (8.2)	1 (6.3)	>0.999*

*Fisher's Exact Test

[†] Wilcoxon signed rank test – p <0.001 admission/discharge meds

[γ] Wilcoxon signed rank test p = 0.001 admission dry/ discharge dry meds

Table 8.3. List of medications by WHO sub group 1 by admission polypharmacy Y or N (n=66)

Medication subgroup	Polypharmacy n=49	No polypharmacy n= 17	*P* value
Alimentary tract and metabolism	**43 (87.8)**	**4 (23.5)**	**<0.001***
Blood and blood forming agents	**40 (81.6)**	**5 (29.4)**	**<0.001**
Cardiovascular system	43 (87.8)	12 (70.6)	0.134*
Dermatologicals	0	1	0.258*
Genitourinary system and sex hormones	3 (6.1)	0	0.563*
Systemic hormonal preparations, excl sex hormones and insulins	13 (26.5)	2 (11.8)	0.318*
Antiinfectives for systemic use	8 (16.3)	0	0.101*
Antineoplastic and immunomodulating agents	3 (6.1)	0	0.563*
Musculo-skeletal system	**21 (42.9)**	**2 (11.8)**	**0.020**
Nervous system	**40 (81.6)**	**6 (35.3)**	**<0.001**
Other Medications	0	0	-
Antiparasitic products, insecticides and repellents	0	0	-
Respiratory system	14 (28.6)	1 (6.7)	0.091*
Sensory organs	9 (18.4)	1 (5.9)	0.432*
Various	0	0	-

* Fisher's Exact Test reported

8.4.4 Polypharmacy and oral health

Polypharmacy was associated with dentition status, being dentate or edentulous, there were more dentate participants with admission polypharmacy (p = 0.034) (Table 8.5). There were no differences in terms of dental decay, periodontal or oral mucosal conditions between those consuming five or more medications daily and those taking less than five. More participants (n=21, 42.9%) with admission polypharmacy reported a dental concern (p=0.036). A multivariate model containing dentition status and reporting a dental concern was statistically significant [χ^2 (4, n=65) = 13.470, p = 0.009]. Both dentition status (p =0.019) and a presenting dental complaint (p=0.041), were independently significant in the model.

Dental referrals and assessments

Two thirds (n=30, 62%) participants reported not seeing a dentist in the past two years (Table 8.5). This is despite many having a presenting dental complaint and 38 (77.6%) were considered in need of a dental referral. Admission polypharmacy was a not predictor of needing a dentist consult (OR 3.1, 95% CI 1.0 – 9.8, p = 0.059).

Table 8.4. Common admission medications categorised by WHO ATC/DDD. Medications with xerogenic potential are highlighted in bold [Total n=66, n (%)].

Anatomical main group	Therapeutic subgroup	Chemical subgroup	Medication name	Polypharmacy n = 49	No polypharmacy n = 17	*P* value
Alimentary tract and metabolism	**Drugs for acid related disorders**	**Proton pump inhibitors**	**Pantoprazole**	**15 (30.6)**	**1 (5.9)**	**0.051***
		Proton pump inhibitors	**Esomeprazole**	**8 (16.3)**	**0**	**0.101***
	Drugs for constipation	Softener, emollients	Docusate sodium	9 (18.4)	2 (11.8)	0.714*
	Drugs used in diabetes	Insulins and analogues for injection, fast-acting	Insulin	5 (10.2)	0	0.317*
		Biguanides	Metformin	6 (12.2)	0	0.326*
		Vitamin D and analogues	Cholecalciferol	13 (26.5)	0	0.015*
	Mineral supplements	Calcium	Calcium carbonate	8 (16.3)	0	0.101*
		Calcium, combinations with vitamin D and/or other drugs	Calcium/Cholecalciferol	10 (20.4)	1 (5.9)	0.264
Blood and blood forming agents	Antithrombotic agents	Vitamin K antagonists	Warfarin	9 (18.4)	0	0.098*
		Platelet aggregation inhibitors excl. heparin	Clopidogrel	6 (12.2)	1 (5.9)	0.667*
		Platelet aggregation inhibitors excl. heparin	**Acetylsalicylic Acid**	**23 (46.9)**	**4 (23.5)**	**0.091**
Cardiovascular system	**Cardiac therapy**	Digitalis glycosides	Digoxin	7 (14.3)	0	0.177*
		Organic nitrates	**Isosorbide mononitrate**	**7 (14.3)**	**0**	**0.177***
	Diuretics	**Sulfonamides, plain**	**Frusemide**	**18 (36.7)**	**2 (11.8)**	**0.054**
	Beta blocking agents	**Beta blocking agents, selective**	**Metoprolol/ metaprolol tartrate**	**5 (10.2)**	**1 (5.9)**	**>0.999***
	Agents acting on the renin-angiotensin system	**ACE Inhibitors and calcium channel blockers**	**Peridopril arginine - amlodipine**	**10 (20.4)**	**1 (5.9)**	**0.264***
	Lipid modifying agents	**HMG CoA reductase inhibitors**	**Simvastatin**	**6 (12.2)**	**2 (11.8)**	**>0.999***

Table 8.4 cont.

Anatomical main group	Therapeutic subgroup	Chemical subgroup	Medication name	Polypharmacy n = 49	No polypharmacy n = 17	*P* value
Cardiovascular system	**Lipid modifying agents**	HMG CoA reductase inhibitors	Atorvastatin	10 (20.4)	2 (11.8)	0.716
		HMG CoA reductase inhibitors	**Rosuvastatin**	**5 (10.2)**	**2 (11.8)**	**>0.999***
Systemic hormonal preparations, excl sex hormones and insulins	Thyroid therapy	Thyroid hormones	Thyroxine	11 (22.4)	2 (11.8)	0.488*
Musculo-skeletal system		Bisphosphonates	Risedronic acid and Risedronic acid combi	7 (14.3)	0	0.177*
Nervous system	**Analgesics**	**Natural opium alkaloids**	**Oxycodone**	**7 (14.3)**	**1 (5.9)**	**0.669**
		Oripavine derivatives	**Buprenorphine**	**7 (14.3)**	**0**	**0.177***
		Anilides	Paracetamol	15 (30.6)	3 (17.6)	0.361*
		Other antiepileptics	**Pregabalin**	**7 (14.3)**	**0**	**0.177***
	Psychoanaleptics	**Non-selective monoamine reuptake inhibitors**	**Amitriptyline**	**6 (12.2)**	**0**	**0.326***
		Other antidepressants	**Mirtazapine**	**5 (10.2)**	**0**	**0.317***
Respiratory system	Drugs for obstructive airway diseases	Selective beta-2 andrenoreceptor agonists	Salbutamol	8 (16.3)	0	0.101*
		Adrenergics in combination with corticosteroids or other drugs, excl. anticholinergics	Fluticasone/salmeterol inhaler	7 (14.3)	1 (5.9)	0.669*

* Fisher's Exact Test reported

Table 8.5. Comparison of dental conditions in relation to polypharmacy (≥ 5 or more medications) on admission [n (%), Mean ± SD].

Dental characteristics	Polypharmacy n = 49	No polypharmacy n = 17	*P* value
Last dental visit >2 years	n=35 20 (57.1)	n=13 10 (76.9)	0.317*
Difficulty chewing or swallowing food	14 (31.1)	4 (28.6)	>0.999*
Reported a dental concern	**21 (42.9)**	n=16 **2 (12.5)**	**0.036**
Dentition status			
Dentate	**29 (59.2)**	**5 (29.4)**	**0.034^**
Edentulous	**20 (40.8)**	**12 (70.6)**	
Number of teeth (Mean ± SD)	16.4 ± 7.6	15.4 ± 7.2	0.723
Oral mucosal condition	20 (40.8)	5 (29.4)	0.404
Dental caries	20 (40.8)	6 (35.3)	0.688
Root surface caries	11 (22.4)	3 (17.6)	>0.999*
Retained roots	8 (16.3)	2 (11.8)	>0.999*
Periodontal condition (BPE>1)	n=24 13 (54.2)	n=5 4 (80.0)	0.370*
Clinically detected or self-reported dry mouth	8 (16.3)	2 (11.8)	>0.999*
Dental referral required	38 (77.6)	9 (52.9)	0.068*
Dentist consult as inpatient	10 (7.4)	3 (6.5)	>0.999*

*Fisher's Exact Test reported
^ This is a p-value for 2 (Dentate/Edentulous) by 2 (Admission Polypharmacy Y/N) cross tabulation. Only one p-value exists.

8.4.5 Combinations of medications and oral health

The different combinations of medications participants were taking were analysed and attempts made to determine whether there were common medications being taken that then led to oral health or dry mouth problems. However, the small oral health assessment and dry mouth participant numbers resulted in insufficient data to proceed with analysis.

8.4.6 Polypharmacy and medical comorbidities in the oral health assessments

The medical comorbidities by polypharmacy are presented in Table 8.6. *Gastrointestinal disorders*, *Renal impairment or disease and Diabetes mellitus,* were entered in a logistic regression model and adjusted for age and gender. The model was significant [χ^2 (5, n=66) = 29.461, p=0.001]. *Gastrointestinal disorders* [OR 15.3, 95% CI 2.712-86.770, p=0.002] and *Diabetes mellitus* [OR 14.3, 95% CI 1.4 – 147.4, p=0.025] remained independently significant, however, the model is again subjected to small sample size particularly in the non-polypharmacy group resulting in very large confidence intervals.

8.4.7 Assessment of sample bias

The comparison between admission polypharmacy in the oral health assessment participants and the non-oral health assessment participants is presented in Table 8.7. All of the oral health assessment participants with polypharmacy were living in their own homes prior to admission (p=0.008). The oral health participants were consuming more overall medications on admission (p=0.027) and more medications on discharge that had xerogenic potential (p=0.015) than the no oral health assessment participants and had a longer stay in hospital (p=0.049). They were similar to each other in all other general health characteristics.

Table 8.6. The main medical comorbidities by admission polypharmacy n=66 [n (%), Mean ±SD].

Comorbidity	Polypharmacy n=49	Polypharmacy n=17	*P* value
Comorbidities	**8.4 ± 3.6**	**5.2 ± 2.0**	**<0.001**
Cardiovascular system	47 (95.9)	14 (82.4)	0.103*
Atrial fibrillation	7 (14.3)	1 (5.9)	0.669*
Cerebrovascular disease	9 (18.4)	2 (18.2)	0.714*
Hypercholesterolaemia	24 (49.0)	8 (47.1)	0.891
Hypertension	33 (67.3)	12 (70.6)	0.805
Ischaemic heart disease	16 (32.7)	4 (23.5)	0.481
Musculoskeletal system	26 (53.1)	10 (58.8)	0.681
Arthritis	15 (30.6)	7 (41.2)	0.426
Osteoporosis	11 (22.4)	5 (29.4)	0.743*
Gastrointestinal system	**25 (51.0)**	**2 (11.8)**	**0.005**
Gastro-oesophageal reflux disorder	**18 (36.7)**	**2 (11.8)**	**0.054**
Respiratory system	18 (36.7)	3 (17.6)	0.145
Diabetes mellitus	**17 (34.7)**	**1 (5.9)**	**0.027***
Thyroid and parathyroid issues	12 (24.5)	3 (17.6)	0.742*
Renal impairment or disease	**13 (26.5)**	**0**	**0.015***
Nervous system	7 (14.3)	2 (11.8)	>0.999*
Cancer	7 (14.3)	1 (5.9)	0.669*
Falls	7 (14.3)	0	0.177

* Fisher's Exact Test

Table 8.7. General characteristics of the oral health assessment participants by admission polypharmacy [n (%), Mean ± SD].

Characteristic	Oral health assessment n=49	No oral health assessment n=86	*P* value
Female	39 (79.6)	62 (72.1)	0.334
Age	83.6 ± 6.5	84.1 ± 6.1	0.812
Preadmission domicile	n=46	n=84	
Own Home	**46 (100.0)**	**73 (86.9)**	**0.008***
Residential care	**0**	**11 (13.1)**	
Reason for admission			
NOF	12 (24.5)	21 (24.4)	0.993
Falls	11 (22.4)	17 (19.8)	0.712
Delirium	6 (12.2)	13 (15.1)	0.645
Respiratory condition	5 (10.2)	7 (8.1)	0.757*
Other fracture	3 (6.1)	6 (7.0)	>0.999*
Multimorbidities	8.4 ± 3.6	7.8 ± 2.8	0.646
In-hospital complications	4.2 ± 2.8	4.2 ± 2.6	0.870
Admission medications	**10.0 ± 3.8**	**8.6 ± 3.0**	**0.027**
Admission dry mouth medications$^{\gamma}$	6.6 ± 2.6	5.9 ± 2.1	0.085
Discharge medications†	12.1 ± 3.6	11.3 ± 3.3	0.189
Discharge dry mouth medications	**7.2 ± 2.2**	**6.4 ± 2.2**	**0.015**
LOS TQEH	**27.1 ± 16.5**	**21.4 ± 13.0**	**0.049**
Discharge location		n=85	
Own Home	29 (59.2)	53 (62.4)	0.717
Residential care	11 (22.4)	19 (22.4)	>0.999*
Rehab	5 (10.2)	9 (10.6)	0.944
Other	4 (8.2)	4 (4.7)	>0.999*

*Fisher's Exact Test

† Wilcoxon signed rank test – p <0.001 admission/discharge meds

$^{\gamma}$ Wilcoxon signed rank test p = 0.001 admission dry/ discharge dry meds

8.5 Discussion

The purpose of this study was to investigate whether medications impact on the oral health of older inpatients, and whether it is possible to predict dental disease based on admission polypharmacy or the types of medications prescribed.

8.5.1 Polypharmacy

Polypharmacy was common at admission and increased to nearly all participants consuming five or more medications daily at discharge. As expected, people prescribed more medications had more medical comorbidities, but were similar to the total study population in most other characteristics, such as age and gender. The differences in preadmission domicile and in-hospital complications is considered to be a random finding, as the geriatricians identified patients for the study, excluding patients with palliative or terminal care needs. The number of participants who received an oral health assessment is small and therefore analysis within the group is limited. However, the finding of common dental diseases among a large proportion of patients is consistent with the findings of other studies conducted in acute care hospitals.[15,24,44,55,71] It is expected that given the general similarities between all participants, the oral health conditions of those who did not get an assessment would also be poor. Patients taking five or more medications daily were more likely to have their own natural teeth and need a dentist consult. However, there were no other associations between dental problems and polypharmacy. This highlights how hard it can be to detect whether patients have dental problems unless you are educated in describing dental disease. While it is known that medications impact the oral cavity, this present study hasn't found any specific associations that could assist physicians to identify patients more likely to have dental diseases or problems. Given this, the findings indicate that older people with polypharmacy and their own teeth need a dental consult. It suggests a 'universal precautions' approach to these patients is the most prudent.

It can be difficult to detect dental disease, pain and oral infections without a comprehensive consult. This oral health assessment did not include radiographs or a validated tool for measuring of saliva flow such as the Xerostomia Inventory (XI).[40] It is expected that both of these two measures would have increased the number of participants with dental or saliva problems. Oral health studies should quantify the amount of saliva, rather than rely solely on the clinical appearance coupled with patient's self-report. It will not always be possible, but when it is at a minimum an orthopantomograph (OPG) radiograph should be obtained to rule out any bony infection or pathology.

8.5.2 Type and combination of medications

Participants were taking medications that are known to have xerogenic potential, and the number of these medications increased during their admission. The oral health assessment revealed that dental disease was common and that most participants required a comprehensive dental assessment. This finding is consistent with similar studies in Australia and abroad.[31,55,71,79] Despite a dental clinic located on-site within the hospital, referral to the dentist by medical staff was not commonplace. The increase in medications, specifically in the categories that are known to cause dry mouth raises concerns of the potential for worsening of the current dental conditions or for patients to develop dental disease in the future. In particular, the increased use of proton-pump inhibitors (PPIs) deserves special attention. The indications for use of PPIs, particularly of long-term higher doses, is less clear than for other medications and should always be reviewed.[126]

Utilisation of the allied health team in oral health screening

Dental practitioners do not traditionally form part of the multidisciplinary team in acute care hospitals in Australia, therefore it is the responsibility of other healthcare professionals, usually nurses to provide oral hygiene care and identify dental problems.[9] The majority of older patients are assessed by a speech pathologist for swallowing and risk of aspiration.[9] A

recent study assessed the ability of speech pathologists to describe the saliva, dentition and oral cavity using the Oral Health Assessment Tool (OHAT) as part of their standard swallowing assessment.[9] They found that speech pathologists were able to use the tool adequately as part of their examination, the authors recommend further research to assess the accuracy of dental referral.

A pharmacist consult on discharge also provides another avenue to alert patients to the potential oral health impacts of medications and to consult their local dentist or general practitioner to follow up on their oral health needs. The medication changes may be short-term, due to pain control for example, but it is also possible that the hospital admission gave physicians and pharmacists the opportunity to rationalise the medication regimen.[114]

8.6 Limitations

The lack of an association with dry mouth is not unexpected given the small number of participants in this study. The use of the Xerostomia Inventory (XI) and a sialometry test may have elicited more saliva-related dental issues and are recommended for cohort, or intervention studies assessing any impact of medications on saliva.[40]

The small numbers in this study have limited the potential to analyse the medication data in detail. In particular, it is disappointing that more detailed analyses of the combination of medications patients did not provide conclusive results. It is recognised that to assess polypharmacy in the context of number, type and combination of medications is challenging.[40]

The lack of medication dosage and duration is a limitation in this study. It would be beneficial to describe changes in number of medications from admission to discharge as it would provide more useful information of the long-term potential for developing dry mouth or dental disease. It is also important to re-evaluate the patient's oral health and medication

status following discharge. This was not possible given this was an exploratory study but will be incorporated into all future studies.

This study does highlight opportunities to conduct more detailed medication analysis that incorporates complexity of medication regimens, patient compliance and the impact on specific health outcomes, such as oral health. Wimmer *et al*.,[127] found that there was limited evidence on the impact of medication complexity on general health outcomes of older people. The intention is to use this exploratory study to develop protocols for future oral health research that includes a multi-disciplinary team familiar with medication complexity analysis.

This is the first Australian study that has attempted to describe polypharmacy with a focus on oral health in a hospitalised older population. It is recognised that researching polypharmacy in dentistry is challenging with many studies focusing on one component – the number, the type or the combination of medications.[40] There is scope to improve the study design in planned longitudinal follow up studies, that will result in more robust medication data that can be assessed to determine the true dental and oral health impact of medications prescribed to older people.

8.7 Conclusion

The number of medications patients were taking increased significantly from admission to discharge and in the participants that received an oral health assessment, dental diseases were common. There is a need to incorporate dental and oral health as a part of the comprehensive geriatric assessments and an acute care hospital admission provides physicians with a unique opportunity to do this. Utilisation of all members of the health care team should be considered in future studies to establish who is best placed to assess oral health and facilitate timely dentist referrals in hospital.

Statement of Authorship

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Contribution to the Paper	Study conception and design, data collection, analysis and interpretation, manuscript writing and editing		
Overall percentage (%)	85%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

iv. the candidate's stated contribution to the publication is accurate (as detailed above);
v. permission is granted for the candidate in include the publication in the thesis; and
vi. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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9. Dental referrals for older patients prescribed antiresorptive medication

Abstract

Background A rare, but potentially debilitating side effect of antiresorptive (AR) therapy is medication related osteonecrosis of the jaw (MRONJ). The risk of developing MRONJ is higher in patients being treated with AR medications for cancer than for osteoporosis however, the increasing number of people aged 65 years and older receiving treatment for osteoporosis coupled with a low priority for dental health means the potential community burden of MRONJ is high.

Methods Discharge summaries were used to collect demographic, general health and medication data in this 12–month cross-sectional study. Participants aged over 65 years were recruited for an oral health assessment modified from the WHO oral health survey. Oral health assessment participants were stratified by AR medication use.

Results Seventy-three people consented to an oral health assessment, 55 (74.0%) were female. Discharge medication data was available for 66 (90.4%). The majority had some form of oral mucosal or dental disease: caries, retained roots or periodontal disease. Twenty-one (75%) of the participants administered antiresorptives during this admission were assessed as needing a dentist consult.

Conclusion Dental disease and poor oral health is common in older people, and in the context of AR therapy this places them at risk of developing MRONJ. The acute care setting provides physicians with an opportunity to conduct a comprehensive geriatric assessment, and simple questions about the dentition, oral health and recency of dentist consults should form part of this assessment.

9.1 Background

Osteoporosis is defined by the World Health Organization (WHO) as *'a progressive skeletal disease characterized by low bone mineral density and microarchitectural deterioration of bone tissue'*.[128,129] One in three women and one in five men over the age of 50 years will experience a fragility fracture which is often the catalyst for a diagnosis of osteoporosis.[128,130] Anti-resorptive (AR) medications are central to osteoporosis management and are very effective at improving bone mass and decreasing risk of spine and hip fractures.[131]

Prior to 2013 oral bisphosphonates, such as: alendronate and risedronate, were the most commonly prescribed medications for osteoporosis in Australia.[132] Patients who have been prescribed oral bisphosphonates for a long time or who have difficulty complying with the oral medication are given intravenous (IV) anti-resorptive medication, such as zoledronic acid or the denosumab (a RANKL inhibitor) as an alternative.[132] Since 2014 prescriptions of denosumab have increased for patients initiating osteoporosis treatment.

9.1.1 Medication related osteonecrosis of the jaw

A rare, but potentially, debilitating side-effect of antiresorptive therapy is medication-related osteonecrosis of the jaw (MRONJ). First reported in the dental literature in 2003, MRONJ is defined as exposed bone or bone that can be probed through a fistula, that has persisted for more than eight weeks, in the absence of any radiation therapy or metastatic bone disease in patients with a history of AR or anti-angiogenic (AA) therapy.[133–135] The risk of developing MRONJ in patients exposed to either intra-venous (IV) zoledronic acid or denosumab for cancer treatment ranges from 0.1 to 2.1 percent.[136,137] The incidence is lower in patients exposed to AR medications for osteoporosis, 0.017 to 0.04 percent.[136,138]

9.1.2 Risk factors for MRONJ

Risk factors for the development of MRONJ include: poor oral health and dental disease, tooth extractions, ill-fitting dental prostheses, smoking, alcohol consumption, poorly controlled diabetes and the duration of AR therapy.[136,139] In 2015 a Drug Safety Update was released by the Medicines and Healthcare Products Regulatory Agency regarding the risk of osteonecrosis of the jaw (ONJ) with intravenous bisphosphonates and denosumab.[130]

Dental neglect is common among older people and coupled with significant barriers to accessing dental treatment, there is increased potential for untreated dental disease to lead to systemic complications.[51,56] Clinical guidelines published in Australia and the United Kingdom (U.K.), endorsed by various medical associations including: The Royal Australian College of General Practitioners, the British Geriatrics Society and the Royal College of General Practitioners respectively, recommend that physicians prescribing antiresorptive therapy advise patients of the risk, albeit low, of developing MRONJ and facilitate a dental assessment prior to, or soon after, commencing the medication.[128,129] Where possible, dental extractions should be avoided once a patient has commenced antiresorptive therapy. Patients should ensure good dental hygiene and maintain an ongoing dental disease prevention program. Similar recommendations are published in a patient brochure developed by the International Task Force on ONJ, representing a group of organizations from Canada and the United States (U.S.).[140] Information presented in these guidelines and recommendations are supported by a recent systematic review on the prevention of MRONJ.[139]

There is currently no scientific evidence for the cessation of AR therapy in order to complete dental treatment. However, studies do present data on the sustained effect of the AR medication on fracture prevention after cessation of the medication.[137,141] This could give physicians and dental practitioners more reassurance in recommending invasive dental treatment if the osteoporosis in considered stable.[137,139,142,143]

The aim of this study was to describe the oral health of hospitalised older people who were taking AR medication for osteoporosis on admission to hospital, or received the medication during their admission, and investigate compliance with recommendations in clinical guidelines regarding dental referral for the prevention of MRONJ.

9.2 Methods

This cross-sectional study was conducted over a 12-month period (September 2013 – August 2014) at TQEH. Discharge summaries were used to obtain information concerning comorbidities, admission and discharge medications and in-hospital complications. Medications were classified according to the WHO Collaborating Centre for Drug Statistics Methodology ATC/DDD system.[87] The medications included as anti-resorptive medications were: alendronate/alendronate combi, risedronate/risedronate combi, raloxifene, zoledronic acid and denosumab.

Selection bias

Geriatricians identified patients deemed medically suitable, not in palliative care or considered to have a terminal condition, for a dental assessment, potentially limiting patients with more serious medical conditions or palliative care needs. In order to assess participant selection bias in the sample, the general health characteristics of those receiving an oral health assessment were compared to age and gender matched patients who were admitted during the same 12-month period but not assessed.

Measurement bias

Oral health assessment and patient interviews were conducted by a single, experienced dental hygienist (Clare McNally) with clinical photographs reviewed by a specialist dentist (Sharon Liberali).

9.2.1 Statistical methods

Oral health assessment participants were stratified by AR medications use. Categorical measures, including sex, reason for admission, polypharmacy and dental characteristics, were summarized as percentages with counts; Pearson's Chi-square test or Fisher's Exact test, used to assess group differences as appropriate. Continuous data were summarized using means with standard deviation and range. The Wilcoxon test was used in lieu of the paired Student's T-test and the Mann Whitney U test in lieu of the t-test for independent samples to assess differences due to violations of normality. All tests were two-tailed and assessed at the 5% alpha level. Length of stay, number of complications and number of discharge medications were treated as count variables and analyzed using a negative binomial regression model to account for over-dispersion in the outcome variables. Logistic regression models were applied to assess discharge polypharmacy as well as antiresorptive therapy on admission and discharge. Data were analyzed in SPSS Version 24.

9.3 Results

Discharge medication data were available for 66 (90.4%) of the oral health assessment participants. The oral health assessment group did not differ from the comparison population in terms of the type of AR medications taken at the time of admission (Table 9.1). During the admission more, oral health assessment participants were administered denosumab (Age and Sex adjusted OR 3.4, 95% CI 1.4-8.4, p=0.009).

Six (46.2%) of the 13 oral health assessment participants had been prescribed a different AR medication at the time of admission and had this changed to denosumab during this admission. Oral health assessment participants taking AR medications were prescribed more medications at discharge (p=0.037) and were also more likely to be taking six or more medications daily (p=0.067) (Table 9.2). A multivariate logistic regression model was developed incorporating the variables (Age, sex and number of discharge medications

significantly associated with prescription of antiresorptive medication prior to or during admission. The model was significant, [χ^2 (3, n=66) = 7.831, p = 0.05], but no individual factor was a predictor of prescription of AR medication.

Table 9.1. Comparison of number of participants [n (%)] taking antiresorptive medications at admission and on discharge.

Admission	**Oral health assessment n = 65**	**No oral health assessment n = 113**	***P* value**
Drugs for treatment of bone diseases	18 (27.7)	23 (56.1)	0.263
Alendronate (inc Alendronate combi)	2 (3.1)	5 (4.4)	>0.999*
Risedronate (inc Risedronate combi)	7 (10.8)	8 (7.1)	0.394
Zoledronic acid	3 (4.6)	5 (4.4)	>0.999*
Denosumab	3 (4.6)	2 (1.8)	0.356*
Raloxifene	1 (1.5)	0	0.365*
Discharge	**Oral health assessment n = 66**	**No oral health assessment n = 130**	***P* value**
Drugs for treatment of bone diseases	28 (42.4)	44 (33.8)	0.239
Alendronate (inc Alendronate combi)	1 (1.5)	6 (4.6)	0.427*
Risedronate (inc Risedronate combi)	7 (10.6)	15 (11.5)	0.845
Zoledronic acid	7 (10.6)	14 (10.8)	0.972
Denosumab	**13 (19.7)**	**9 (6.9)**	**0.007**

*Fisher's exact test reported

Table 9.2. Comparison of the general health characteristics [n (%), mean (SD)] of participants who received the oral health assessment, in relation to antiresorptive medication use.

Characteristic	Antiresorptive medication n = 28	No antiresorptive medication n = 38	*P* value
Age, mean (SD)	84.1 ± 6.4	83.6 ± 6.7	0.805
Female, n (%)	**25 (89.3)**	**26 (68.4)**	**0.046**
Reason for admission			
NOF	11 (39.3)	7 (18.4)	0.060
Falls	7 (25.0)	9 (23.7)	0.902
Delirium	3 (10.7)	4 (10.5)	> 0.999*
Respiratory disorders	2 (7.1)	4 (10.5)	> 0.999*
Other fractures	2 (7.1)	2 (5.3)	> 0.999*
Number of multi-morbidities, mean (SD)	7.4 ± 3.0	7.8 ± 3.9	0.953
Number of complications	4.3 ± 2.7	4.3 ± 2.6	0.989
Total number of admission meds, mean (SD)	8.8 ± 4.7	7.9 ± 4.4	0.415
Admission polypharmacy, n (%)	21 (77.8)	28 (73.7)	0.706
Total number of discharge meds	**12.1 ± 3.2**	**10.2 ± 4.3**	**0.037**
Discharge polypharmacy, n (%)	28 (100)	33 (86.6)	0.067*
Length of hospital stay (days)	24.7 ± 16.8	27.9 ± 17.5	0.467
Died this admission	0	0	N/A

*Fisher's exact test reported

The oral health characteristics did not differ between those administered AR medications in hospital and those not (Table 9.3). Eleven (39.3%) people in the AR group had dental caries, three (10.7%) had root surface caries and four (14.3%) had retained roots. Two-thirds (n=29/47, 61.7%) of participants reported that it was more than two years since they had seen a dentist, despite three-quarters (n=49/66, 74.2) being considered in need of a referral to the dentist. (Table 9.3). When adjusted for age and sex, *Last dental visit >2 years ago* resulted in a significant model, [$\chi^2(3, n=47) = 14.842$, $p = 0.002$]. Both sex and last dental visit remained statistically significant in the model, however the odds ratios and 95% confidence intervals of the two variables were extreme indicating neither variable was a good predictor of antiresorptive medication prescription.

Table 9.3. Dental characteristics [n (%), mean ± SD] by antiresorptive (AR) medication.

Characteristic	Antiresorptive medication n = 28 n (%)	No antiresorptive medication n = 38 n (%)	*P* value
Dentition status			
Dentate	16 (57.1)	18 (47.4)	0.432*^
Edentulous	12 (42.9)	20 (52.6)	
Number of teeth	15.9 ± 7.9	17.5 ± 5.7	0.681
	n=19	**n=28**	
Last dental visit > 2 years ago	**10 (52.6)**	**20 (71.4)**	**0.004**
Self-reported chewing or swallowing problem	6 (25.0)	12 (35.3)	0.404
	n=27		
Chief dental complaint	10 (37.0)	14 (36.8)	0.987
Clinically detected or self-reported dry mouth	5 (17.9)	6 (15.8)	>0.999*
Oral mucosal condition	12 (31.6)	12 (42.9)	0.347
Dental caries	11 (39.3)	15 (39.5)	0.988
Root caries	3 (10.7)	11 (28.9)	0.073
Retained roots	4 (14.3)	7 (18.4)	0.747*
	n=12	n=16	
Periodontal condition (BPE>1)	7 (58.8)	10 (62.5)	0.638
Dental referral recommended	21 (75.0)	28 (73.7)	0.904

[a] as recorded in the Basic Periodontal Examination
[*] Fisher's exact test reported

9.4 Discussion

Dental diseases were common among participants administered AR medications during their hospital admission and in the context of the potential for developing MRONJ, these are possible sources of infection. However, none of the participants taking AR medications were seen by the dentist during their hospital admission. Furthermore, their oral health condition was not commonly reported in the discharge summary, reducing the salience of the problem for general practitioners to encourage follow up with the dentist.

The oral health assessment group differed from the broader geriatric population in number of complications, length of stay in hospital and number of discharge medications. This suggests that this group may be more likely to have dental disease. However, given terminally ill, palliative care, and total hip arthroplasty patients were excluded from recruitment to the oral health assessment part of the study, it is possible that these findings are incidental, and that the oral health of the broader older population is similar to that found in this study.

The data suggests that untreated dental disease is common among older people and an acute care admission provides physicians with an opportunity to incorporate oral health into the geriatric assessment and where there is an on-site dental clinic, facilitate referral and treatment. The small sample size of 73 oral health assessments makes it difficult to discuss generalisability. However, other studies of oral health in the acute care setting over the past 20 years have reported similar results.[12,55,71,78] Dental neglect is a common theme as people prioritise other aspects of health. Two recent Australian studies present similar results of poor oral health and dental disease and also conclude that the acute care medical setting provides a unique opportunity to assess the oral health of older patients.[15,24]

Common dental diseases, dental caries and periodontal disease, if treated early do not usually lead to systemic infection. However, if left untreated they can lead to localized abscesses or cellulitis.[145] Participants in this study had dental caries and gingival or periodontal disease

and had not recently seen the dentist. These participants already have the potential for dental infection that could lead to MRONJ and are not in routine dental hygiene maintenance programs.

Identifying patients at risk of developing MRONJ is a key component in prevention.[139] Three-quarters of the participants were considered by the research team to require referral to the dentist. While 28 were taking antiresorptives during their hospital stay, it is not known how many of the remaining participants will be prescribed antiresorptives in the future. The oral health status of these patients puts them at risk of developing MRONJ, particularly in the event of invasive dental treatment. This reinforces the importance of including oral health as a component of geriatric assessments in hospital.

In the acute hospital setting where physicians' workload is high, and patient's length of stay is variable, the pharmacist or nurse practitioner could be responsible for arranging on-site dental referrals (where dental clinics exist) for patients prescribed antiresorptive medications.

This study focusses on instances of referral to the onsite hospital dental service. It is difficult to determine whether geriatricians gave patients advice to seek out their own dental care on discharge as documentation of this in discharge summaries was limited. Prospective studies investigating the risk of developing MRONJ should emphasize the importance of ongoing oral health prevention and maintenance messages for physicians and patients.

9.5 Limitations

The use of one clinician for the oral health assessments eliminates inter-operator variability but may introduce measurement bias. External dental review of intraoral photographs by a dentist were incorporated as a measure to counter this bias. The timeframe of this study limited the opportunity to conduct follow-up assessments that may have confirmed any oral impact from medication use.

This was a novel study, being the first dental study conducted at this hospital. Future oral health studies need to incorporate a team of calibrated clinicians to collect data and be conducted as longitudinal studies, with follow up dental assessments and interviews. Dental radiographs would also be beneficial.

There are limitations associated with the collection of medication data. This data was retrieved from the discharge summaries rather than Med Maps or a pharmacist consult. A small number of participants did not have discharge medication data recorded and it was sometimes difficult to interpret duration and dose.

9.6 Conclusion

Undoubtedly, antiresorptive medications have a critical role in the prevention of fractures and the high mortality that often accompanies hip fractures. Current recommendations for improving oral health and facilitating dental treatment prior to commencing antiresorptive medication are not being followed. Strategies are required to improve the implementation of these recommendations to avoid placing potentially vulnerable people at risk of MRONJ. The acute care setting provides physicians with an opportunity to conduct a comprehensive geriatric assessment, and simple questions about the dentition, oral health and recency of dentist consults should form part of this assessment.

10. Dental department utilisation

Abstract

Background Dental and oral diseases are the most common unmet needs of older people and can have significant impact on systemic health. Generally older people do not attend the dentist regularly and so novel approaches are needed to improve access to oral health services and reduce the burden of disease. The aim of this study was to explore referral patterns to the on-site dental department and determine whether they were influenced by the presence of a dental hygienist on the ward, ***Methods*** A six-year (January 2011 – December 2016) retrospective audit was undertaken to determine the referral patterns to the on-site dental clinic before, during and after the oral health study (Chapter 6) was implemented in the NOF and GEMU wards. 900 participants (100 GEMU and 50 NOF each year) were randomly sampled from the hospital admission records. Discharge summaries and dental department encounters were used to obtain medical and dental data. Complete data was available for 805 participants. ***Results*** A total of 78 (9.7%) patients were referred to the dental department between January 2011 and December 2016. The group of participants referred to the dentist had a significantly higher number of in-hospital complications ($p < 0.001$) and length of hospital stay ($p < 0.001$). The most common reason for referral to the dental department was for a review prior to commencing antiresorptive medications. ***Conclusion*** The number of referrals to the dental department was small but it did increase over the course study and continued to increase once the study was completed. There needs to be a shift in healthcare models that see dental professionals incorporated into the allied healthcare team in hospitals and other health settings not normally synonymous with dentistry.

10.1 Background

Dental and oral diseases are the most common unmet needs of older people and the impact of poor oral health on general health has been highlighted in the previous chapters of this thesis.[6] There is literature dating back two decades describing the barriers older people face in accessing dental care and yet in 2018 the situation in Australia has not changed with only 51 percent of people aged over 65 years visiting the dentist, decreasing to 41 percent of people aged 85 years and older..[1,4,10–12] Older people are less likely to seek out dental care due to cost, perceived lack of need or inability to access a dental surgery.[1,145]

Deterioration in dental and oral health is a personal and public health issue which can be exacerbated by an acute hospital admission.[22,104] There is limited data available locally or internationally that details the oral health of acutely hospitalised older adults.[15,24,25,104] The research that does exist all surmises that a novel approach is required to facilitate better comprehensive care for patients including improving oral health.[9,15,24]

The World Health Organisation (WHO) recommends interprofessional collaborative practice as a means of delivering the highest quality care to patients and their families, however, historically medicine and dentistry have operated as separate entities.[146–148] The divide may exist, or persist, because doctors and dentists tend to operate in non-integrated practices, and dental professionals are rarely employed in hospital settings.[60,147,148] The disconnect between medicine and dentistry is most felt by underserviced populations or those on low or fixed incomes, who have difficulty affording private dental care.[60,149]

People who are unable to afford private dental care, or who spend long time on public dental waiting lists, often present to the emergency department of hospitals for relief of pain.[147] Kruger and Tennant[3] found that over a 10-year period (1999-2009) hospitalisation due to a dental or oral health problem increased for people aged 65 years and older and that one of the main reasons for admission was dental caries, a preventable disease. It is projected that due to

retention of natural teeth and the ageing population, the number of hospital admissions for oral health problems will double by 2025.[3]

Poor oral health in the context of an acute hospital admission not only impacts quality of life but increases the risk of in-hospital complications resulting in significant morbidity and potentially increases mortality risk.[104] A more compelling reason to develop mechanisms for improving the oral health of older people does not exist. The aim of this study was to assess physician referral patterns to the on-site dental department for patients admitted to the Orthopaedic (NOF) and Geriatric Evaluation and Management Unit (GEMU) wards during the years 2011 - 2016.

10.2 Methods

This component of the study was conducted to determine if the presence of a dental hygienist on the Orthopaedic and GEMU wards had an impact on the number of patients referred to the on-site dental clinic by the geriatricians and physicians.

10.2.1 Methods

A six-year (January 2011 – December 2016) retrospective audit was undertaken to determine the referral patterns to the on-site dental clinic before, during and after the oral health study was implemented. The number of participants chosen for recruitment is presented in Chapter 4, Table 4.9, and was based on the number of participants recruited to the oral health study. For each year of the audit, 100 GEMU participants and 50 NOF participants were selected. The total sample population was 900. To select the participants a number was assigned to all the patients admitted each year and a random number generator was then used to select patients from each list. This process was completed for each ward to ensure 100 from the GEMU and 50 from the Orthopaedic wards were sampled.

The medical records of the 900 participants were screened and a total of 95 (105%) were excluded (Table 4.9). Forty (44.4%) participants had no discharge summary for the

admission. Thirty-five (36.7%) had a duplicate recording for the admission, this occurred when there was a long hospital stay, these records were merged and considered as one admission. The final sample of 805 participants included 543 (67.5%) GEMU admissions and 262 (32.5%) NOF admissions.

Electronic medical records were then accessed, and the following data recorded for each patient:

1. Age
2. Sex
3. Length of hospital stay (days)
4. Reason for admission
5. Number of comorbidities
6. Number of in-hospital complications
7. Number of admission medications
8. Number of discharge medications
9. Dental referral (Yes/No)
10. Reason for dental referral
11. Description of oral health status included in discharge summary
12. Died during admission

A copy of the research protocol is presented at Appendix 3.

10.2.2 Statistical analysis

Categorical measures were summarized as percentages with counts; Pearson's Chi-square test or Fisher's Exact test were used to assess group differences as appropriate. Continuous data were summarized using means with standard deviation and range. The Wilcoxon test was used in lieu of the paired Student's T-test and the Mann Whitney U test in lieu of the t-test for independent samples to assess differences due to violations of normality. All tests were two-tailed and assessed at the 5% alpha level. The analyses were completed using SAS v9.4 (SAS Institute Inc., Cary, NC, USA) and SPSS v25.0 (IBM SPSS Statistics for Macintosh, Armonk NY: IBM Corp).

10.3 Results

A total of 78 (9.7%) of 805 patients were referred to the dental department between January 2011 and December 2016. The participants referred to the dentist were similar in age, sex and number of medical comorbidities to those who were not referred (Table 10.1). The majority of referrals were from the GEMU ward (n=56, 71.8%) but there was no statistical difference in referral patterns. Both groups were taking a similar number of admission and discharge medications. There was a significant increase in the number of medications taken at discharge for both groups ($p < 0.001$).

The group of participants referred to the dentist had a significantly higher number of in-hospital complications ($p < 0.001$) (Table 10.1). The specific complications were not recorded. The GEMU patients had a higher mean number of complications (5.2 ± 3.0) compared to the NOF admissions (2.7 ± 2.7) ($p <0.001$).

The GEMU patients also had a longer stay in hospital (21.6 ± 15.1 days compared to 14.4 ± 14.5, $p <0.001$). Patients referred to the dentist, regardless of reason for admission, also had an increased length of stay in hospital (p=0.001).

These variables were entered into a logistic regression model to determine whether they were predictors of dental referral. The model was significant and remained so following adjusting for age and sex [χ^2 (4, n=756) – 12.183, p = 0.016). However, only in-hospital complications remained independently significant (OR 1.102, 95% CI 1.019-1.193, p=0.015).

The most common reason for referral was a dental review prior to commencing anti-resorptive medication therapy (Table 10.2). Other reasons for dental referral included a dental consult, denture review and trauma from a fall. Table 10.3 shows the pattern of referral over the 6-year audit period. There were only two (1.5%) dental referrals in 2011 and 28 (21.9%) in 2016.

Table 10.1. Comparison of general characteristics between people referred to the dentist and those not.

Characteristics	Dental referral n = 78	No dental referral n = 727	*P* value
Female	50 (64.1)	479 (65.9)	0.752
Age	85.1 ± 6.7	83.5 ± 8.2	0.232
Reason for admission *NOF* *GEMU*	 22 (28.2) 56 (71.8)	 249 (34.3) 478 (65.7)	 0.283~
Multimorbidities	7.7 ± 3.4	7.2 ± 3.6	0.129
Complications	**5.5 ± 2.8**	**4.3 ± 3.1**	**<0.001**
Admission medications	8.2 ± 3.4	7.8 ± 4.1	0.355
Discharge medications^	10.6 ± 3.7	10.4 ± 4.1	0.622
Length of stay (days)	**23.8 ± 15.1**	**18.6 ± 15.2**	**0.001**
Described in notes	65 (83.3)	2 (0.3)	>0.999*
Died this admission	1 (1.3)	32 (4.4)	0.358*

* Fishers exact test
^ Wilcoxon signed rank test – both groups p<0.001 for change in medications from admission to discharge
~ 2x2 table

Table 10.2. The reasons for dental referral as described in the patient discharge summaries.

Reason for referral	Total 78 n (%)
Review prior to AR therapy	58 (74.4)
Consult	6 (7.7)
Trauma from a fall	2 (2.6)
Denture review	2 (2.6)
Swelling	1 (1.3)
Previous MRONJ	1 (1.3)
Poor dentition	1 (1.3)
Unknown	7 (9.0)

Table 10.3. Physician referrals to the dental department total by ward (NOF or GEMU) [n (%)]

Year and number of admissions	Total	GEMU	NOF	*P* value
2011 n=136	2 (1.5)	2 (2.3)	0	0.540*
2012 n=138	5 (3.6)	3 (3.2)	2 (4.4)	0.661*
2013 n=137	11 (8.0)	10 (11.0)	1 (2.2)	0.099*
2014 n=129	16 (12.4)	9 (10.3)	7 (16.7)	0.307
2015 n=134	16 (11.9)	11 (12.8)	5 (10.4)	0.786
2016 n=128	28 (21.9)	21 (24.4)	7 (16.7)	0.370

* Fisher's Exact Test

10.4 Discussion

The total number of referrals over the six-year study period are small, but they did increase during the time the oral health study was conducted in the ward and continued to increase after the data collection was completed. There is a possibility a "Hawthorne effect" was responsible for the increase in referrals.[150] This effect describes people modifying or changing their behaviour because they are being observed. The effect demonstrated in the Hawthorne studies, is not always sustained following completion of the study. However, during the entire course of the PhD candidature (2012 – 2017) I provided regular oral health seminars for the medical, nursing and research staff at TQEH and University of Adelaide. The presence of a dental hygienist on the ward is not considered to be the sole reason for the increase in referrals.

The participants in this study were similar to the oral health assessments participants described in the Chapter 6, in that they had longer hospital stay and increased in-hospital complications. There are no other factors to use to compare these populations, however, this is an interesting finding that warrants further investigation. Is the level of dental disease and oral health contributing to in-hospital complications that result in an increased hospital stay? Perhaps patients who are required to stay in hospital longer have time to have a dental assessment.

In this six-year audit of the records of 805 patients in a tertiary hospital with an on-site dental clinic less than ten percent of patients over the whole study period were seen by the dentist. No specific comparable studies have been found to compare these results to. The Kruger and Tennant[3] paper shows that oral health problems are significant and older people are increasingly being admitted to acute hospitals as a result of dental infection. This presents an opportunity for procedural changes that address the oral health needs of older people in the interests of total patient care. The previous chapters of this thesis have already outlined the

barriers for older people accessing dental services and the difficulty in using medical information to identify patients in need of a dentist consult. Addressing the oral health needs of patients during an acute hospital admission seems sensible, in reality it will be more complex given the obvious priority is preservation of life and medical management of the patient. Therefore, the approach needs to include various allied health professions: nurses, speech therapists and pharmacists in addition to dental professionals. Collaboration with general medical practitioners to ensure oral health recommendations are followed up post-discharge also appears to be another avenue to explore.

Based on the information presented in this thesis and in particular in Chapter 9 Anti-resorptive medications, it was expected that more patients from the Orthopaedic Unit would have been referred over the course of the audit, and that this would continue following the completion of the oral health study. The main reason for referral was a *review prior to antiresorptive therapy* but only seven percent of the 805 patients included in the audit were referred for this review. This assumption is based on the amount of time I spent in the orthopaedic ward and in educating the nursing and speech pathology staff. The NOF participants in the oral health study did have a shorter length of stay as there is a tendency to transfer them to rehabilitation centres for functional improvement necessary following such a significant fracture.

Utilisation of the dental workforce outside the traditional dental surgery setting is crucial to better integration of medicine and dentistry.[60,151] Dental education programs need to be adjusted to incorporate dentistry in the non-clinical setting.[151] However, healthcare systems are slow to change and there is evidence to show that better utilisation of other members of the allied health team may also improve the oral health of older inpatients and increase dental referrals.[9,15,24] Intervention studies that utilise nursing staff to assess and perform oral hygiene often conclude that nurses are too time poor and often dislike or feel unprepared for the

provision of someone else's toothbrushing.[10] Speech therapists are already making an oral assessment and usually fairly soon after admission.[9] They could be considered the most valuable member of the allied health team to educate in dental and oral health assessments and the need for referrals. Pharmacists conduct medication reviews and are responsible for the delivery of the medications to wards for administration. They are another important member of the allied health team already employed in hospitals who are able to advise medical and allied health staff of the contraindications or adverse reactions associated with certain medications, including oral side effects that should be considered.

10.5 Limitations

A limitation of this audit was using the discharge summary and dental department encounter data as the main source of information. These are both subject to error through omission, people forgetting to upload information. More meaningful referral data could have been obtained by cross-checking the discharge summary with referrals received by the dental department.

The use of discharge summaries also resulted in a lack of defined medical comorbidities, medications and in-hospital complications that could have led to more detailed analysis on whether oral health problems were responsible and therefore increased the length of hospital stay. Hospitalisation has been shown to have a negative impact on oral health, particularly in terms of plaque accumulation in intubated patients.[22,104] It is not possible to determine whether this was an outcome for the patients included in this audit and further research into oral health management, and dental referrals, for all inpatients is recommended.[22,104]

This study focused on the wards where the oral health study was conducted. Expansion of the study to other wards for comparison of the rate of referral would have been beneficial and should be considered in light of the impact hospitalisation is known to have on oral health.[22,104]

10.6 Conclusion

The acute hospital admission is an ideal time to consolidate all aspects of a patient's general health. The oral and dental health must be considered a part of general health. The number of participants referred to the on-site dental department over a six-year time period is small and disappointing given the oral health needs of older people. The presence of a dental hygienist on the ward resulted in a small increase in referrals. There needs to be a shift in healthcare models that see dental professionals incorporated into the allied healthcare team in hospitals and other health settings not normally synonymous with dentistry.

11. Discussion

11.1 Contribution and impact

This exploratory study has assessed the oral health of older patients admitted to an acute care hospital and examined general health factors that may be associated with poor oral health. I also investigated how oral health needs are addressed in a hospital with an on-site dental clinic. The results indicate that untreated oral and dental diseases are common in older people regardless of whether they were living independently in the community or in residential aged care prior to their admission to hospital. It also demonstrates how difficult it is to identify oral health needs without an intra-oral assessment as there were no common characteristics among the participants that could aid physicians in identifying patients needing a dental referral. It is unclear from the results whether poor oral health had any impact on in-hospital complications, an aspect of future hospital-based dental studies that requires further exploration.

11.2 The orthopaedic surgeon survey

The planned oral health study was significantly different to the one presented in this thesis and focused on patients with a neck of femur (NOF) fracture and their recovery and post-discharge health outcomes and any association with oral health. Due to the limitations placed on patient recruitment the project was redesigned. However, this was an unexpected complication as the geriatric medical team not consider antibiotic prophylaxis would be required for the dental assessment. Since the recommendation was removed from the Australian Therapeutic Guidelines in 2010, this was also unexpected from the dental team. This survey provided insight into the surgeon's opinions on the association between dental disease and prosthetic joint infection (PJI).

It is interesting to consider the number of surgeons who consider dental intervention is responsible for PJI compared to the number who recommend dental referral prior to elective prosthetic joint replacement (PJR). There is potential evidence of availability bias, with surgeons linking patients PJIs to recent dental treatment, when there is minimal evidence to suggest such an association exists.[98]

While there is no suggestion that this survey resulted in the change to the Arthroplasty Society of Australia (ASA) guidelines, it is interesting to consider the timeframe between the completion of the survey and their guideline change. It is also important to note that this change away from the prescription of antibiotic prophylaxis for patients with PJRs is in line with the Australian and international guidelines.[97,98]

11.3 Oral health status

Chapter 6 shows that despite predictions of decreasing edentulism, half of the participants in this study had no natural teeth. Dental decay, ill-fitting dentures and oral mucosal conditions were all common and 75 percent of participants were considered in need of a referral to the dentist. There was a need to recommend the geriatricians arrange urgent referral for three participants for infection associated with retained roots. Dental assessments do not usually form part of comprehensive geriatric assessments (CGAs) and Chapter 6 suggests an opportunity is being missed to provide patients with inclusive health care management, given the impact oral and dental infection can have on systemic health.

There have been four similar oral health hospital-based studies in Australia conducted between 2004 and 2017.[15,24,79,80] All four studies found that oral health on admission was poor and both Gibney *et al*.,[24] and Danckert *et al.,*[80] found that the oral health status worsened during the hospital admission. There is a common conclusion in all four studies that there needs to be increased awareness of oral health problems and requirements for older people

admitted to acute care, but also that there is a need to change oral health delivery models to improve access to services.

Kruger *et al*.,[79] conducted the first study in 2004 and present strikingly similar results to the present oral health study. Three-quarters of their participants required referral to the dentist, despite few reporting a dental concern. Dental diseases were common. Similarly, Kruger *et al*.,[79] did not conduct an intervention. They concluded that increasing the availability of services will not necessarily result in improved oral health outcomes and a broader approach that includes oral health education of nursing and care staff is necessary.

Ni Chroínín *et al.,*[15] and Gibney *et al*.,[24] used the Oral Health Assessment Tool (OHAT) to determine oral health status. The OHAT is a screening tool designed for use by allied health professionals without a dental background, such as nurses and speech pathologists, to identify patients in need of referral to the dentist.[9] Both these studies reported participants with poor oral health, it is likely that there is an underestimation of the dental diseases present such as dental caries when using a screening tool. However, in light of the need to consider alternative health delivery models to address the ageing population, and the underutilisation of using dental professionals in non-traditional settings such as hospitals, it is worthwhile exploring the use of the OHAT in future hospital-based studies.

There have been several international hospital-based oral health studies. Two key bodies of work stand out as providing the most comprehensive information on the oral health status and needs of hospitalised older people. The Geriatric Oral Science Project by Loesche *et al*., conducted in the late 1980's and 1990's in a US. Veteran's Affairs (VA) hospital in the United States (U.S.), compared independent living, hospitalised and nursing home participants.[7,37,153,41,42,46,72,73,75–77,152] Meurman and Pajukoski *et al*., conducted a similar study in the 1990's Finland, where they compared the oral health on hospitalised and non-hospitalised older people.[38,43,44,71,78] Both of these bodies of work present similar findings

with hospitalised older people having an oral health status similar to people living in residential care. Many people have untreated dental diseases, likely to result in infection and with the potential to impact on general health or recovery. It is alarming that little has changed in the results from the earliest paper produced from the Geriatric Oral Science Project to the oral health study presented in this thesis. That is nearly 30 years of investigation and discussion of how to improve access to dental services and address the oral health needs of hospitalised older people.

The study limitations that impacted on the ability to produce sturdier, generalisable results are disappointing, but they don't detract from the opportunity to use the information gained in this study to develop a robust longitudinal, intervention study. Recruitment of older people to research, particularly when they are unwell is difficult.[81] This study also suffered from a saturation of data, with so many health measures to collect, the main investigator spent much time gathering non-essential information. It is suggested that a Cohort-Multiple Randomised Controlled Trial (cmRCT) study design would limit unnecessary data collection and focus researchers on the intervention.[83] This has been outlined in detail in Chapter 13.

11.4 Polypharmacy and medication use

This is the first Australian, hospital-based oral health study to attempt to quantify the impact of polypharmacy and individual medication use on oral and dental health. Polypharmacy was common at admission and increased to nearly 100 percent of the sample population at discharge. As expected, people prescribed more medications had more medical comorbidities, but were similar to the total study population in most other characteristics, such as age and gender. Kruger *et al*.,[79] reported a similar average number of daily medications [Mean 9.3 (SD 4.1)]. They also reported that three-quarters of the participants with dry mouth symptoms were prescribed medications with oral side-effects.[79] There was no

further breakdown on medication type to determine whether specific medications or medication groups were responsible for dental problems.

In the present study, the number of participants who received an oral health assessment is small and therefore analysis within the group is limited. However, the finding of common dental diseases among a large proportion of patients is consistent with the findings of other studies conducted in acute care hospitals.[15,24,44,55,71] Further exploration of the association between medications and oral health in the hospitalised older population is necessary, but in this study, patients with admission polypharmacy were more likely to have natural teeth (or a combination of natural teeth and dentures) and also reported having a dental chief complaint.

The number of participants in this study with dry mouth is small (n=10 of 66, 15.2%). Thomson (2015) describes the wide-ranging prevalence of xerostomia, but highlights that there is a large variety in the way saliva and dry mouth data is collected and recorded.[40] The present study relied on self-report or clinically detectable dry mouth data, rather than using a specific tool. As Thomson (2015) describes, there are two types of dry mouth that need to be investigated. Xerostomia, the subjective feeling of dry mouth, and the type most likely to be a result of medication use, can be assessed using the Summated Xerostomia Inventory (SXI). A short, five-item questionnaire. Salivary gland hypofunction needs to be assessed using sialometry, the collection of unstimulated and stimulated salivary flow. Neither of these tools were used in this study and limited conclusions can be drawn on the specific role medications had in salivary changes. Due to the time limitations, I was unable to follow the patients up during their admission and assess any salivary changes that may have occurred due to hospitalisation.

Medications prescribed for cardiovascular diseases, nervous system disorders, gastrointestinal and musculoskeletal problems are all known to have oral side effects, most commonly changes to salivary flow resulting in a dry mouth.[153] A larger sample could allow for more

comprehensive analysis of the combination of medications that lead to dry mouth. However, it is possible that older people are more likely to have dry mouth simply due to the number of anticholinergic medications they are prescribed, rather than any specific type of medication. Medication complexity, an inability to take oral liquids and use of oxygen therapy are all associated with hospitalisation and with xerostomia.[39,154] Management of dry mouth symptoms should form part of an acute hospital admission and may alleviate the potential for worsening of dental diseases. However, given the low priority of oral health in hospitals, coupled with the likely increase in number of daily medications by discharge it is expected that oral health will continue to worsen, regardless of the discharge location.

In our hospital, speech therapists consult all geriatric patients to determine swallowing capacity and aspiration risk and pharmacists work closely with physicians to administer medications. There is an opportunity to utilise both of these health professions to conduct oral health screening and recommend referral where necessary. Speech therapists, in particular, inspect the oral cavity and can be educated in conducting the OHAT screening tool.[9]

The early oral health hospital-based studies highlighted that there was a need to consider alternative health care models to address the changing health needs of the ageing population.[42,71,79] There is a theme building throughout this thesis that suggests an acute care hospital admission provides a unique opportunity to address the oral health needs of older people. This requires a shift in the way dentistry has traditionally been delivered, in a dental surgery, and the realisation that it is unlikely dental professionals will be employed in hospitals in any great numbers. Education and upskilling of speech therapists, nurses and pharmacists to assist physicians in oral health management is a logical alternative and should form part of any intervention study.

11.5 Antiresorptive medication

Chapter 9 considers antiresorptive (AR) medications that are very effective at improving bone mass and decreasing risk of spine and hip fracture in patients with osteoporosis.[131] A rare, but potentially debilitating side-effect of AR medications is medication-related osteonecrosis of the jaw (MRONJ).[134] The risk for developing MRONJ is greatest in those prescribed AR or antiangiogenic medications for metastatic cancer, no-one in this study was taking these medications for that purpose.

Medication-related osteonecrosis of the jaw is defined as exposed bone or bone that can be probed through a fistula, that has persisted for more than eight weeks, in the absence of any radiation therapy or metastatic bone disease in patients with a history of AR or anti-angiogenic (AA) therapy.[133–135] While MRONJ can develop spontaneously, it more commonly forms following invasive dental treatment such as extraction.[134] The clinical guidelines for patients who are prescribed AR medications recommend a dental consult prior to commencing the medication, or as soon as practicable following commencement of the medication.[128,129,140]

As with the previous chapters, Chapter 9 describes yet another opportunity for the oral health needs of an older person to be addressed during an acute hospital admission. Pharmaceutical Benefits Scheme (PBS) data suggests a decline in the use of medication for the management of osteoporosis since 2014 with speculation this is due to concern over MRONJ.[132] Given the low rates of attendance of older people to the dentist, it is possible that a dental assessment has not been conducted prior to commencing the medication.[1] There is also the possibility that patients will be shifted from an oral antiresorptive to a sub-cutaneous or intravenous antiresorptive in hospital as there are sometimes issues with the compliance of the oral form.[132]

Taking the medication is vital for older people with osteoporosis and the risk of MRONJ is very low but can be difficult to manage once the condition is established. Good oral hygiene and being free from dental infection are key to the prevention of MRONJ.[134,138] This section of the thesis continues the theme of a need for a multidisciplinary approach to the management of the oral health needs of older people, and also highlights another oral-systemic health association that can significantly impact on quality of life.

11.6 Dental department utilisation

One of the key findings of this study was the lack of dental referrals to the on-site dental department over a 6-year period. No other studies that report on dental referral patterns within a hospital were found. Many studies have described the oral health needs of older people in various aspects of the aged care sector: community, hospital and residential care, but they have not explored whether non-dental clinicians are referring to the dentist. Only a small percentage (n=78, 9.7%) over the 6-year audit period were referred.

Chapter 6 shows that poor oral health and dental disease are common as was multimorbidity and in-hospital complications. The medication chapters of this thesis highlight how salivary flow can be disrupted due to polypharmacy resulting in a dry mouth that increases the risk of dental disease or exacerbates progression of diseases already present. Despite not being confirmed in the present study, Chapter 2 demonstrates that there is an association between oral and systemic health whereby dental disease and inflammation can increase the risk of cardiovascular and respiratory diseases and malnutrition. It also impacts on quality of life due to an inability to communicate or eat properly leading to increasing social isolation.

In the context of an acute care hospital admission it is understandable that the focus of medical staff is on the preservation of life with the goal of discharge with preadmission functionality but doing this at the exclusion of other health priorities increases the risk that patients will fail to recover full and be re-hospitalised.

12. Limitations

The limitations of this study were introduced in Chapter 1. Implementing the first oral health study in a tertiary institution posed significant challenges. Some of these were overcome easily and by the completion of the data collection period nursing and allied health staff were embracing oral health and engaging with the dental hygienist on the ward. However, from a research perspective, these limitations presented challenges that reduced the potential for meaningful results necessary for changing clinical practice and procedures. This chapter describes the study design and sample limitations in more detail and also describes the steps taken by the team to reduce the potential for bias.

12.1 Study design

There were deficiencies in the study design that presented early in the process. The study was always going to be limited as it was a single-centre study. But further to that this study was developed by the Aged & Extended Care unit who has a strong ortho-geriatrics team for managing patients post neck of femur (NOF) fracture surgery. Unfortunately, the orthopaedic surgeons were not consulted until initial study development was complete. This was a significant oversight, that resulted in limitations on patient recruitment by the orthopaedic surgeon team, these have been discussed in detail throughout the thesis. The surgeons were reluctant to allow a dental assessment for patients who had a total or hemi hip arthroplasty, total or half joint replacement. The reasoning was the potential for prosthetic joint infection (PJI) due to the introduction of bacteraemia during the dental assessment. This was an unforeseen complication as from the dental perspective, patients with joint replacements are not considered to be at risk of PJI and can potentially benefit by the identification of dental problems and infection. This not only impacted on the study sample but delayed the commencement of the study by more than six months as it was redesigned.

The initial study design in pre-planning was very detailed and well thought through. The oral health assessments were to occur at three-time periods: baseline, 6 and 12-month follow up. Unfortunately, due to the redesign of the study and the delay in obtaining ethics, the study was reduced to a single timepoint to allow for completion within the PhD candidature.

12.2 Study sample

12.2.1 Neck of Femur Fractures

The original aim of this thesis was to explore the oral health of patients hospitalised with a neck of femur fracture. However, this was modified after the orthopaedic surgeon team restricted access to patients who have internal fixation only, excluding patients with total or hemi-arthroplasties. This reduced the potential sample size from 300 patients to 160 patients in the 12-month period based on the previous 24-month period. Unfortunately, in the first month of the study, there were few patients with internal fixation repair and so an amendment was sought to conduct the study in both the NOF patients and patients admitted to the Geriatric Evaluation and Management Unit (GEMU). The general health characteristics of the NOF and GEMU patients given an oral health assessment are presented in Table 12.1. This table shows how the two participants were similar in the majority of general characteristics but differed in length of hospital stay (p=0.027) and in the discharge to own home (p=0.026).

This shifted the focus from how oral health impacts on aspects of general health in NOF patients, to how oral health impacts the general health of hospitalised older inpatients in general. While this was another disappointing change in terms of delays and a change to the original research protocol it did increase the medical, nursing and allied health team's exposure to dentistry and resulted in me presenting regularly to the wards and nursing grand rounds on the importance of oral health. It was not until after the study was completed that I

Table 12.1. Comparison of the general health characteristics between the NOF and GEMU participants [Total n = 73, n (%), Mean ± SD].

Characteristic	NOF n=22	GEMU n=51	*P* value
Female	18 (81.8)	37 (72.5)	0.399
Age	84.1 ± 7.3	84.6 ± 6.4	0.909
Preadmission domicile *Own Home* *Residential care*	 18 (94.7) 1(5.3)	 48 (96.0) 2 (4.0)	 >0.999*†
Comorbidities	6.5 ± 3.3	7.9 ± 3.5	0.076
In-hospital complications	4.0 ± 3.1	4.8 ± 2.6	0.104
Admission polypharmacy	12 (70.6)	37 (75.5)	0.752
Admission medications	6.4 ± 2.9	8.8 ± 4.9	0.057
Admission dry mouth medications	4.5 ± 2.3	5.9 ± 3.1	0.083
Discharge polypharmacy	18 (100.0)	43 (89.6)	0.312
Discharge medications	11.7 ± 2.7	10.8 ± 4.3	0.426
Discharge dry mouth medications	7.4 ± 2.0	6.3 ± 2.6	0.189
Total length of stay (days)	**22.2 ± 16.6**	**28.3 ± 17.3**	**0.027**
Discharge location *Own Home* *Residential care* *Rehab* *Other*	 **7 (31.8)** 6 (27.3) 6 (27.3) 3 (13.6)	 **29 (60.4)** 12 (25.0) 4 (8.3) 3 (6.3)	 **0.026** 0.840 0.061* 0.370*
Death this admission	0	3 (5.9)	0.549

* Fisher's Exact Test reported

† This is a p-value for 2 (Own home/RACF) by 2 (Oral health assessment Y/N) cross tabulation. Only one p-

considered how valuable an evaluation of these presentations could have been to the overall results of the study.

The limitations on patient recruitment outlined in each chapter and detailed in the methods section significantly reduced the potential of this research project and relegated it to a pilot or exploratory study where the idiosyncrasies of conducting dental research in a medical setting have helped shape future research study design to improve the study rigour and outcomes for patients.

12.3 Measurement bias

The use of one clinician for the oral health assessments eliminates inter-operator variability but may introduce measurement bias. External dental review of intraoral photographs by a dentist were incorporated as a measure to counter this bias. The timeframe of this study limited the opportunity to conduct follow-up assessments that may have confirmed any oral impact from medication use. This was a novel study, being the first dental study conducted at this hospital. Future oral health studies need to incorporate a team of calibrated clinicians to collect data and be conducted as longitudinal studies, with follow up dental assessments and interviews. Dental radiographs would also be beneficial.

There are limitations associated with the collection of medication data. This data was retrieved from the discharge summaries rather than Med Maps or a pharmacist consult. A small number of participants did not have discharge medication data recorded and it was sometimes difficult to interpret duration and dose.

12.4 Study Design

A lot of extra data was collected because of the study design. Better study designs exist specifically for working with the elderly that with hindsight would have improved the robustness of the results, the validity and the generalisability. They would have also reduced

the workload of data collection, collation and entry to allow more time for focusing on patient recruitment. Chapter 13. Suggestions for future research details how the cmRCT research design is an alternative that should be considered for follow up studies.

13. Impact and suggestions for future research

This exploratory study has presented a poor state of oral health in hospitalised older people and had a small, but positive impact on the utilisation of the on-site dental clinic. Despite the limitations imposed on the study design, there is opportunity to use the results of this study to formulate a comprehensive oral health study that has the potential to make a meaningful difference in the oral health-related quality of life of older people.

13.1 Study design

The design of the present study did not take into consideration the amount of work that was required to collect and collate such a large amount of medical and dental data. The preferred study design to gain meaningful results would be the fairly recently described cohort multiple randomised controlled trial (cmRCT), developed specifically for research with older people.[83,155] This design allows for a large observational cohort study with a condition of interest (for example hospitalised in acute care) and incorporate all the regular measurements that are routine. In the present study, this data collection process was not considered prior to the implementation of the study and the design was based on a frailty study being conducted simultaneously.

The previous chapter outlines how important it is to communicate with all key stakeholders and personal likely to be involved in the study. Use of the cmRCT study design could assist with the implementation of the study into different wards and clinical settings. The focus of the dental data collectors could be solely on the oral health assessments rather than collecting all of the general health information from patients, which would allow for better use of time for implementation of an oral health intervention.

'The cmRCT approach also enables detailed observational and qualitative research for the chosen condition of interest, and might include the establishment of research biobanks to better align basic science, epidemiological, qualitative and clinical trial research.' Clegg *et al.,*[83]

13.2 Participants

Recruitment and retention of older people to healthcare studies is difficult.[155] The cmRCT study design is a useful design for recruitment of older people as it considers all potential participants in the study sample. In the present study this would mean that all patients admitted to the hospital during the study period could have been recruited to the study, using an opt-out consent where people are given the option of not having their data included. Participants can then be randomly allocated to the study and offered the intervention, or the additional aspect of the study such as an oral health assessment and oral hygiene intervention. The study design allows for comparison of outcomes between the whole population and the randomly selected participants. This has the potential to improve recruitment and lead to more generalisable results.

This study design does raise questions for ethics and governance. It was first presented as an option for pragmatic trials when multiple interventions may be utilised.[156] Young-Afat *et al*.,[156] in 2013 introduced the study design into a clinical oncology research setting which led to robust discussion on the ethic of this study design. They present three pathways of patient recruitment that do not interfere with best practice treatment.[156] Given their considerably more serious study of patients in oncology, this methodology can be easily applied to hospitalised people undergoing a dental intervention.

13.3 Research setting

Chapter 2 outlined how much of the research into the oral health of older people has been conducted in residential aged care facilities (RACFs). This drove the implementation of the present study in a hospital setting. Future studies need to incorporate all potential sectors of the older population: independently community living, hospitalised patients and people living in RACFs. Based on the Geriatric Oral Science Project, conducting the study in a variety of settings would also enable more detailed and meaningful results.[42,43] Thomson and Ma (2014) describe how oral health deteriorates rapidly following admission to residential care.[4] Mapping the oral health of a large cohort of older people living independently in the community, through hospitalisation and residential care admission would assist in the planning of protocols for addressing the oral health needs of older people and reducing the barriers to accessing dental services.[10,11,26]

13.4 Research protocol

A deficiency of much of the geriatric oral health research is the lack of follow up.[2,44] The cmRCT longitudinal cohort study design does allow for follow up and repeated data collection that would be suitable for an oral health study. It also allows for different health professionals: speech therapists, dental hygienists and pharmacists to research different aspects of oral health with the same study population.

13.5 Implications from this study

The implications that this review has for both researchers and clinicians is described below, with suggestions for the composition of the dental assessment to ensure results that will shape future efforts in geriatric dental research and ensure any associations between oral health and systemic health can be identified and measures taken to avoid them.

13.5.1 For the clinician

Improvements need to be made in the provision of daily oral hygiene in the acute care setting. Many of the oral health problems presented in this study are related to the presence of dental plaque, resulting from poor oral hygiene. Further education in dental assessments could be a useful and important addition to the skill set of hospital-based physicians and allied health staff and could contribute to appropriate referrals for patients who will benefit without overwhelming available services.

Geriatricians need to consider dental referrals as part of their total patient care. In the same way input from a number of health professionals such as physiotherapists, speech pathologists and dietitians form part of a patient's stay in hospital then dental input could become part of routine multidisciplinary team geriatric care. The results of this review suggest there is an opportunity to improve the dental primary care model in the hospital setting, by utilising the dental workforce rather than adding to the workload of physicians and nurses.

Despite the limitations, this study does highlight the need for dental hygienists and oral health therapists to be considered as integral members of the allied health team within hospitals and aged facilities. The deficiencies in study design do not negate that fact that one dental hygienist was able to identify compromised oral health in the majority of patients assessed in such a small study. There is potential to better use all sectors of the oral health workforce and improve total patient care, by considering it standard to have dental personal on staff in healthcare settings.

13.5.2 For the dental researcher

It is valuable for the dental researcher to consider the limitations faced in this exploratory study and take time to prepare the research design in detail. This is particularly important when conducting research outside traditional dental settings.

The baseline data needs to be comprehensive and report on all key aspects of oral and general health. Ideally, the tools used to measure oral and general health should have been previously validated. Self-reported oral health measures, whilst important in pertaining to quality of life, do not give an accurate picture of the dental state and are potentially unreliable in this population without clinical corroboration.

The majority of the following information was incorporated into this study, however more robust recording, for example the dose and frequency of medications is recommended and using validated data collection tools wherever possible. Therefore, a comprehensive geriatric dental research study should include the following data as standard baseline information:

Medical information

- Admission and discharge day and time
- CALD characteristics
- Number of medical comorbidities
- Smoking history
- Depression status and general quality of life information
- Medications: name, classification, dose and frequency
- Reason for hospitalisation, surgical procedures and ASA-PS if known
- Any validated tools used to collect health information: MNA-SF, MMSE, ADLs, PAIN-AD
- Dietary information: food preparation and chewing and eating capacity
- Swallowing assessment
- Postoperative complications
- Frailty index
- Length of hospital stay
- Discharge location

- In-hospital mortality
- Quality of life and Oral health-related quality of life

Dentition status

- Dentate, edentulous, use of dentures

Dental condition

- The mean number of natural teeth
- Functional units – both natural and prosthetic

Oral hygiene

- Utilising a recognised and repeatable oral hygiene index such as Greene and Vermilion, which uses a debris and calculus index to develop and overall oral hygiene score.

Caries (coronal and root surface):

- Report the number of carious lesions and although not ideally suited to the older population the decayed, missing, filled teeth (DMFT) and decayed, missing, filled surfaces (DMFS) have relevance where participants are increasingly dentate[157]

Periodontal disease

- Screening using a tool such as the Basic Periodontal Exam[32]

Mucosal screening

Salivary flow rate

- Stimulated salivary flow rate (SSFR), unstimulated salivary flow rate (USFR), Self-reported saliva status, use of the Xerostomia Inventory (XI) and sialometry.

OPG radiographs where possible

Comprehensively reported, the above information will give a very clear indication of the participant's oral health and the potential impact it has on the general health outcome of interest.

It is important to move away from conducting further cross-sectional research. What is needed are well constructed longitudinal studies, potentially utilising the cmRCT design, that are multidisciplinary and multi-centred. Then perhaps there will be actual improvement in the oral health status of older people.

14. Summary and conclusions

This work has identified significant oral disease and problems in older people admitted to acute care hospital. Polypharmacy at admission was an indicator of the need for a dental referral however, no other specific medical indicators were found that could be used to identify patients with dental disease suggesting a 'universal precautions' approach should be taken. However, based on the number of participants with undetected dental conditions in this study, older hospitalised people should be assessed for dental and oral health problems. It is recognised that older inpatients are assessed by a speech pathologist and have their medications reviewed by a pharmacist. Both of these health professionals could recognise and be involved in the identification of dental problems that require referral.

The ageing population, with more complex dental needs face the same barriers to accessing dental services as they did thirty years ago. The shift to a natural dentition which complicates dental treatment and increases the risk of systemic health issues of dental origin has occurred without any modification of the dental healthcare model. The main theme that developed during the course of this study was the need for interprofessional collaboration to identify and manage dental problems outside the traditional dental surgery. Dental attendance among older people is poor, and hospitalisation rates for dental conditions are increasing. Utilisation of allied health personnel including nurses, speech therapist and pharmacists is vital. Medicine and dentistry, for the most part, operate in isolation of each other reducing the opportunity for people to gain access to holistic healthcare.

Limitations on study design reduced the impact and potential of this study but should not be considered negatively as they highlight key issues that would need to be addressed in the development and implementation of a longitudinal cohort or cohort-multiple randomised controlled trial (cmRCT) study. Although this study style has not been tested in Australia in

dental research. Conducting oral health studies within a tertiary hospital and among allied and medical health professionals is challenging. The limitations identified in this study will be crucial to the development of the next phase of this research, a comprehensive older adult oral health study.

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16. Appendices

APPENDIX 1. MEDICAL JOURNAL OF AUSTRALIA SNAPSHOT

This snapshot was taken of a patient who under the care of Dr. Sharon Liberali and myself at the Special Needs Unit, Adelaide Dental Hospital. This was a timely case considering the limitation placed on the patient recruitment.

Statement of Authorship

Title of Paper	Oral health: an important consideration in patient care
Publication Status	Published
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Principal Author

Name of Principal Author (Candidate)	Clare McNally		
Contribution to the Paper	Photograph and manuscript writing and editing		
Overall percentage (%)	90%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature	[redacted]	Date	6/6/19

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Sharon Liberali		
Contribution to the Paper	Manuscript revision (10%)		
Signature	[redacted]	Date	10.11.16

Oral health an important consideration in total patient care

Severe radiation caries, which caused major psychological distress to the patient, occurred in a 57-year-old man after treatment for recurrent squamous cell carcinoma in the base of the tongue. Despite a post-radiation caries prevention program, surgical and radiation complications caused an inability to maintain effective oral hygiene, resulting in the progression of radiation caries (Figure). One month after the photograph in the Figure was taken, the patient underwent total hip replacement surgery. During subsequent post-operative appointments, the patient received antibiotic prophylaxis, but dental rehabilitation was delayed by 3 months to avoid potential early infection of the implant. This serves as a reminder to medical practitioners to encourage patients to seek regular dental care and consider a dental assessment before major surgery.

Appendix 4 - Figure 1. An example of severe radiation caries

APPENDIX 2. THE ORAL HEALTH STUDY PROTOCOL

OHNOFF Study

Baseline and 30-day Mortality

PATIENT DETAILS		
Title: Mr/Mrs/Miss/Ms		
Hospital UR Number:		
Medicare Number:_ _ _ _ /_ _ _ _ _ /_		
Name:		
Date of Birth:	Age:	Gender: 1 □ M 2□ F
Address:		
Telephone:		
Next of Kin (including relation to patient)	Next of Kin Contact Phone/Address	
GP Name	GP Phone/Address	
Dentist	Dentist Phone/ Address	

General health and admission data

ADMISSION DATA			
Date of admission to hospital	___/___/20___ Date_Admit_Hosp	Time of admission to hospital	Time_Admit_Hosp
Admitted to the hospital from Time of admission to Ortho U	FROM Time_Ad_OrthoU	Date of admission to Orthopaedic Unit Which department was the pt admitted to the ortho unit fm	___/___/20___ Date_Admit_OrthoU Admitted_to_Ortho_from
Date of admission to GEMU	Date_Admit_GEMU	Time of admission to GEMU	Time_Ad_GEMU
Which department was the pt admitted to the GEMU fm	Admit_to_GEMU_from	Time from admission to the hospital to GEMU	Time_fm_admis_gemu
Reason admitted to hospital	REASON	If infection, type of infection (String and code later)	Type_of_inf
Type of hip fracture	TYPEHF	Hip Fracture details	TYPEHF_Details
Other fracture (not NOF)	OTHERTYPEFrac	Previous best mobility prior to admission	BESTMOB
Braden Skin Score	BRADEN		
Surgery Date	___/___/20___ SURGDATE	Time of surgery	Time_SURG
Time from admission to surg	Time_fm_admis_surg	Time from emerg to ortho U	Time_fm_emerg_orthou
Length of time spent in HDU	Length_of_time_in_HDU	Length of time spent in ICU	Length_of_time_in_ICU
Type of Prosthesis	TYPEPROS	ASA physical status	ASA-PS
Type of anaesthetics (general, regional or comb)	TYPEANAES	mg	VASOPRESS_1
mg/kg	VASOPRESS_2	mg/kg/min	VASOPRESS_3
Invasive monitoring use	INTRAOP_INV	From above	INTRAOP_OTHER
Post-operative destination	POSTOPDEST	Time spent in recovery	TIMEREC

ADMISSION: MEDICATIONS – Separate coding of individual drugs to be completed later			
Total number of meds	T1TOTAL_MED	Polypharmacy? (> 6 prescribed medications)?	T1PLYPHARM

ADMISSION: DEMOGRAPHICS, HEALTH AND LIFESTYLE			
Birthplace	BIRTHP	English as Primary Language:	LANG
Aboriginal or Torres Strait Islander Descent	ATSI	Interpreter Used to Collect data?	INTUSED
Lives alone	T1ALONE	Marital Status	T1MARRY
Living Accommodation:	T1ACCOM	Other Accom	T1ACCOMOTHER
Pensioner Status	PENSION	Private Health Insurance	INSUR
Primary Caregiver	CARER	Carer used to help with answers	ANSWERS
Regular help prior to illness or injury? (From patient Clinical Record where possible or else patient/carer)	T1HELP	Do you currently drive	T1DRIVE
Highest Level of Education:	EDUC		

SMOKING AND ALCOHOL STATUS AND HISTORY			
Smoking Status	T1SMOKE	Are you interested in quitting	T1INT_QUIT
Amount smoked each day	T1AMOUNT_SMOKE	Attempted to quit	T1QUIT_SMOKE
Length of time smoking for	T1TIME_SMOKE	How many years had you been smoking before you quit	T1YEAR_QUIT
		How many cigarettes did you smoke each day before you quit	T1AMOUNT_QUIT
Alcohol Consumption	T1ALCOHOL		

PRE-BASELINE – FALLS HISTORY

Pre-Baseline: "These questions are related to the time before you were admitted to hospital. Therefore, thinking back to one month ago before you fractured your hip....."

Number of falls in the last 12 months?	T1FALLS	Services you have used in the past 3 months	T1SERVICES
Presentation to the hospital for fall related injury in last 12 months	T1ED_FALLS	Number of visits to hospital as per OACIS?	T1HOSP_VISITS
Before the admission, have you been reviewed in the following for your falls	T1FALLS_CLINIC	Number of days in hospital	T1HOSP_DAYS

ADMISSION – Baseline Blood Test Results

Results from OACIS on admission

Date taken:

C-reactive protein	T1CRP	Haemaglobin	T1Hb
Total White Cell Count	T1TWCC	Serum Albumin	T1SerumA
% Neutrophils	T1%NEUT	Vitamin D	T1VITD
Iron	T1Fe		

ADMISSION – Day 3 Blood Test Results

Results from OACIS, subsequent test if taken

Date taken:

C-reactive protein	T1CRP_A	Haemoglobin	T1Hb_A
Total White Cell Count	T1TWCC_A	Serum Albumin	T1SerumA_A
% Neutrophils	T1%NEUT_A	Vitamin D	T1VITD_A
Iron	T1Fe_A	Day post admission	BTDAY_A

ADMISSION – Discharge Blood Test Results

Results from OACIS, subsequent test if taken

Date taken:

C-reactive protein	T1CRP_A	Haemoglobin	T1Hb_A
Total White Cell Count	T1TWCC_A	Serum Albumin	T1SerumA_A
% Neutrophils	T1%NEUT_A	Vitamin D	T1VITD_A
Iron	T1Fe_A	Day post admission	BTDAY_A

General dental and food – to be collected by the PI			
Difficulties in cutting food?	T1FOOD1	Difficulties in swallowing or chewing food?	T1FOOD2
Lack of transportation to shops?	T1FOOD3	Unable to use cooking items, such as pots, & the oven?	T1FOOD4
Difficulties in purchasing food? (financial constraints)	T1FOOD5	Meals usually eaten	T1MEALS
What type of health professional did you last see about your teeth	T1NHSORAL_2	In the last 2 weeks have you consulted a dentist or dental professional for your teeth, dentures or gums	T1NHSORAL_3
How many consultations in the last 2 weeks	T1NHSORAL_4	When was the last time you consulted a dentist or dental professional	T1NHSORAL_5
Number of consultations required at this time (related to above)	T1NHSORAL_6	Do you usually go to a dentist for treatment, a check-up or both	T1NHSORAL_7
Where did you last visit the dentist?	T1NHSORAL_8	Have you lost any of your teeth, excluding wisdom teeth	T1NHSORAL_10
How many teeth have you lost?	T1NHSORAL_11	Number of teeth from NHSORAL_11	T1NHSORAL_12
Do you wear any dentures or false teeth which can be removed?	T1NHSORAL_13	Do you need to get false teeth so that you can eat properly?	T1NHSORAL_14
During the last 12 months was there ever a time you needed to go to a dentist but didn't	T1UNMET_Q1	Why didn't you go?	T1UNMET_Q2
In the last 12 months have you lost any natural teeth or had any teeth extracted	T1LOSTTHW5		

Oral Health Impact Profile (OHIP-14)

Baseline oral health impact profile (OHIP-14) – to be completed by the PI					
Please indicate the extent to which you agree or disagree with each of the following statements	Never	Hardly ever	Occasionally	Fairly Often	Very Often
Have you had trouble pronouncing any words because of problems with your teeth, mouth or dentures? T1OHIP1					
Have you felt that your sense of taste has worsened because of problems with your teeth, mouth or dentures? T1OHIP2					
Have you had painful aching in your mouth? T1OHIP3					
Have you found it uncomfortable to eat any foods because of problems with your teeth, mouth or dentures? T1OHIP4					
Have you felt self-conscious because of problems with your teeth, mouth or dentures? T1OHIP5					
Have you felt tense because of problems with your teeth, mouth or dentures? T1OHIP6					
Has your diet been unsatisfactory because of problems with your teeth, mouth or dentures? T1OHIP7					
Have you had to interrupt meals because of problems with your teeth, mouth or dentures? T1OHIP8					
Have you found it difficult to relax because of problems with your teeth, mouth or dentures? T1OHIP9					
Have you been a bit embarrassed because of problems with your teeth, mouth or dentures? T1OHIP10					
Have you been a bit irritable with other people because of problems with your teeth, mouth or dentures? T1OHIP11					
Have you had difficulty doing your usual jobs because of problems with your teeth, mouth or dentures? T1OHIP12					
Have you felt that life in general was less satisfying because of problems with your teeth, mouth or dentures? T1OHIP13					
Have you been totally unable to function because of problems with your teeth, mouth or dentures? T1OHIP14					

Question	Possible results
Do you have the things you need to clean your teeth here in hospital?	CLEANTEETH
Have you had your teeth cleaned for you since coming to hospital	CLEANHELP
Are your dentures removed at night?	DENTUREHELP

Geriatric Depression Scale Short Form (GDS-SF)

Depression – to be recorded in the ward by a medical practitioner
Depression
T1GDS

GDS-5/15 Geriatric Depression Scale

Each of these are a yes, no question – the depressed answers are noted in parentheses below.
A. Are you basically satisfied with your life? (No)
B. Do you often get bored? (Yes)
C. Do you often feel helpless? (Yes)
D. Do you prefer to stay at home, rather than going out and doing new things? (Yes)
E. Do you feel pretty worthless the way you are now? (Yes)

SCORE FROM FIRST 5 QUESTIONS: ____

If 2 or more, please give remaining 10 questions.

F. Have you dropped many of your activities and interests? (Yes)
G. Do you feel your life is empty? (Yes)
H. Are you in good spirits most of the time? (No)
I. Are you afraid something bad is going to happen to you? (Yes)
J. Do you feel happy most of the time? (Yes)
K. Do you feel you have more problems with memory than most? (Yes)
L. Do you think it is wonderful to be alive now? (No)
M. Do you feel full of energy? (No)
N. Do you feel that your situation is hopeless? (Yes)
O. Do you think most people are better off than you? (Yes)

SCORE FROM ALL 15 QUESTIONS: ____

A total of 5 or more on the entire test suggests depression.

Dementia

A diagnosis of dementia – to be taken from the medical records	
Dementia	Type of Dementia
T1DEM	T1TYPE_DEM

Abbreviated Mental Test/Mini Mental Test Score

AMT/MMTS – to be used in the NHFS, questions to be asked by PI	
Question	Answers
What is your age? (1 point)	
What is the time to the nearest hour? (1 point)	
Give the patient an address, and ask him or her to repeat it at the end of the test. (1 point) e.g. 42 West Street	
What is the year? (1 point)	
What is the name of the hospital or number of the residence where the patient is situated? (1 point)	
Can the patient recognize two persons (the doctor, nurse, home help, etc.)? (1 point)	
What is your date of birth? (day and month sufficient) (1 point)	
In what year did World War 1 begin? (1 point)	
Name the present monarch/dictator/prime minister/president. (1 point)	
Count backwards from 20 down to 1. (1 point)	
Total	
	T1MMTSTOT

Mini-mental state examination

MMSE – to be recorded in the ward by a medical practitioner
MMSE (score out of 30)
T1MMSE

RUDAS

RUDAS – to be recorded in the ward by a medical practitioner
RUDAS (Score out of 30)
T1RUDAS

The Charlson's Comorbidity Index.

CCI – calculate with information from the pts medical record	
CCI	T1CCI
From program – age adjusted	CCI_Age Adjusted
Number of comorbs	CCI_NoofComorbs

Assigned weights for diseases	Conditions
1	Myocardial infarct Congestive heart failure Peripheral vascular disease Dementia Chronic pulmonary disease Connective tissue disease Ulcer disease Mild liver disease Diabetes
2	Hemiplegia Moderate or severe renal disease Diabetes with end organ damage Any tumour Leukaemia Lymphoma
3	Moderate or severe liver disease
6	Metastatic solid tumour AIDS

Nottingham Hip Fracture Score

NHFS – to use the smart phone application to calculate this NHFS		
	T1NHFS	
Variable	Value for entry into app	Patient Score
Age	<66 66–85 yr ≥86 yr	
Sex	Male	
Admission Hb	≤10 g dl^{-1}	
MMTS (AMT)	≤6 out of 10	
Living in an institution	Yes	
Number of co-morbidities	≥2	
Malignancy	Yes	
Total		

Delirium

Delirium – to be recorded in the ward by a medical practitioner			
Delirium	T1DEL_DAY1	Delirium	T1DEL_DAY3
Delirium	T1DEL_DAY5	Delirium	T1DEL_DAY7

Confusion Assessment Method (CAM) Diagnostic Algorithm

Feature 1: *Acute Onset or Fluctuating Course*
This feature is usually obtained from a family member or nurse and is shown by positive responses to the following questions: Is there evidence of an acute change in mental status from the patient's baseline? Did the (abnormal) behaviour fluctuate during the day, that is, tend to come and go, or increase and decrease in severity?

Feature 2: *Inattention*
This feature is shown by a positive response to the following question: Did the patient have difficulty focusing attention, for example, being easily distractible, or having difficulty keeping track of what was being said?

Feature 3: *Disorganized thinking*
This feature is shown by a positive response to the following question: Was the patient's thinking disorganized or incoherent, such as rambling or irrelevant conversation, unclear or illogical flow of ideas, or unpredictable switching from subject to subject?

Feature 4: *Altered Level of consciousness*
This feature is shown by any answer other than "alert" to the following question: Overall, how would you rate this patient's level of consciousness? (alert [normal]), vigilant [hyperalert], lethargic [drowsy, easily aroused], stupor [difficult to arouse], or coma [unarousable])

The diagnosis of delirium by CAM requires the presence of features 1 and 2 and either 3 or 4.

Participant ID Number:

Health Questionnaire

English version for Australia

EQ5 – to be taken from the completed survey							
Category Pt Score	Mobility	Selfcare	Activity	Pain	Anxiety	State	EQ_VAS
Code	T1EQ-5D-5L_1	T1EQ-5D-5L_2	T1EQ-5D-5L_3	T1EQ-5D-5L_4	T1EQ-5D-5L_5	T1EQ-5D-5L_6	T1EQ-5D-5L_7

Under each heading, please tick the ONE box that best describes your health TODAY

MOBILITY
I have no problems with walking around ❑
I have slight problems with walking around ❑
I have moderate problems with walking around ❑
I have severe problems with walking around ❑
I am unable to walk around ❑

PERSONAL CARE
I have no problems with washing or dressing myself ❑
I have slight problems with washing or dressing myself ❑
I have moderate problems with washing or dressing myself ❑
I have severe problems with washing or dressing myself ❑
I am unable to wash or dress myself ❑

USUAL ACTIVITIES *(e.g. work, study, housework, family or leisure activities)*
I have no problems doing my usual activities ❑
I have slight problems doing my usual activities ❑
I have moderate problems doing my usual activities ❑
I have severe problems doing my usual activities ❑
I am unable to do my usual activities ❑

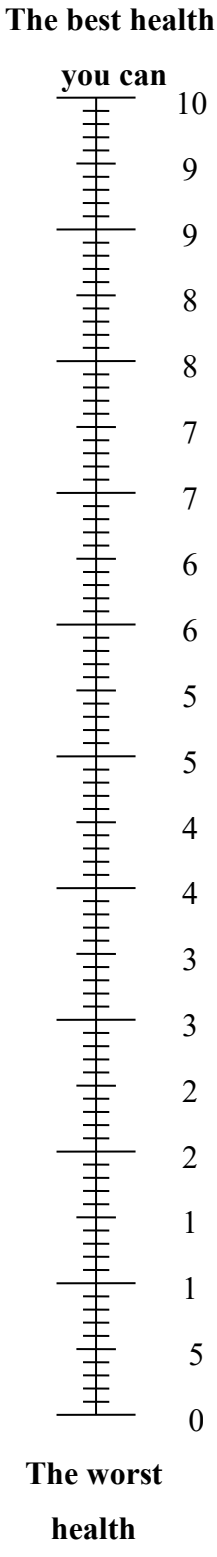
PAIN / DISCOMFORT
I have no pain or discomfort ❑
I have slight pain or discomfort ❑
I have moderate pain or discomfort ❑
I have severe pain or discomfort ❑
I have extreme pain or discomfort ❑

ANXIETY / DEPRESSION
I am not anxious or depressed ❑
I am slightly anxious or depressed ❑
I am moderately anxious or depressed ❑
I am severely anxious or depressed ❑
I am extremely anxious or depressed ❑

Participant ID Number:

We would like to know how good or bad your health is TODAY.
This scale is numbered from 0 to 100.
100 means the best health you can imagine.
0 means the worst health you can imagine.
Mark an X on the scale to indicate how your health is TODAY.
Now, please write the number you marked on the scale in the box below.

YOUR HEALTH TODAY = ☐



Baseline Frailty Index

Frailty – to be recorded in the ward by a medical practitioner in consultation with the PI	
Frailty on admission	Frailty on discharge
T1FRAILTY_AD	T1FRAILTY_DIS

Clinical Frailty Scale*

1 **Very Fit** – People who are robust, active, energetic and motivated. These people commonly exercise regularly. They are among the fittest for their age.

2 **Well** – People who have **no active disease symptoms** but are less fit than category 1. Often, they exercise or are very **active occasionally**, e.g. seasonally.

3 **Managing Well** – People whose **medical problems are well controlled,** but are **not regularly active** beyond routine walking.

4 **Vulnerable** – While **not dependent** on others for daily help, often **symptoms limit activities.** A common complaint is being "slowed up", and/or being tired during the day.

5 **Mildly Frail** – These people often have **more evident slowing,** and need help in **high order IADLs** (finances, transportation, heavy housework, medications). Typically, mild frailty progressively impairs shopping and walking outside alone, meal preparation and housework.

6 **Moderately Frail** – People need help with **all outside activities** and with **keeping house**. Inside, they often have problems with stairs and need **help with bathing** and might need minimal assistance (cuing, standby) with dressing.

7 **Severely Frail** – **Completely dependent for personal care**, from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying (within ~ 6 months).

8 **Very Severely Frail** – Completely dependent, approaching the end of life. Typically, they could not recover even from a minor illness.

9. **Terminally Ill** - Approaching the end of life. This category applies to people with **a life expectancy <6 months**, who are **not otherwise evidently frail.**

Scoring frailty in people with dementia

The degree of frailty corresponds to the degree of dementia. Common **symptoms in mild dementia** include forgetting the details of a recent event, though still remembering the event itself, repeating the same question/story and social withdrawal.

In **moderate dementia**, recent memory is very impaired, even though they seemingly can remember their past life events well. They can do personal care with prompting.

In **severe dementia**, they cannot do personal care without help.

* 1. Canadian Study on Health & Aging, Revised 2008.
2. K. Rockwood et al. A global clinical measure of fitness and frailty in elderly people. CMAJ 2005;173:489-495.

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Participant ID Number:

PAIN-AD

PAIN-AD – to be calculated by the nurse or medical practitioner			
PAIN-AD	T1PAIN-AD_DAY1	PAIN-AD	T1PAIN-AD_DAY3
PAIN-AD	T1PAIN-AD_DAY5	PAIN-AD	T1PAIN-AD_DAY7

Items	0	1	2	Score
Breathing independent of vocalisation	Normal	Occasional laboured breathing. Short period of hyperventilation.	Noisy laboured breathing. Long period of hyperventilation. Cheyne-Stokes respirations.	
Negative vocalisation	None	Occasional moan or groan. Low-level speech with a negative or disapproving quality	Repeated troubled calling out. Loud moaning or groaning. Crying.	
Facial expression	Smiling or inexpressive	Sad. Frightened. Frown	Facial grimacing.	
Body language	Relaxed	Tense. Distressed pacing. Fidgeting	Rigid. Fists clenched. Knee pulled up. Pulling or pushing away. Striking out.	
Consolability	No need to console	Distracted or reassured by voice or touch	Unable to console, distract or reassure.	
Total				

Scoring:
The total score ranges from 0-10 points. A possible interpretation of the scores is: 1-3=mild pain; 4-6=moderate pain; 7-10=severe pain.

Katz Activities of Daily Living

ADLs – to be calculated by the PI in consultation with nurse or medical practitioner			
Premorbid ADLs (1 month prior to admission)	T1KATZADL_PREB	Admission/ Hospitalised ADLS	T1KATZADL

Activities Pre-morbid	Activities Morbid	Independence (1 point) NO supervision, direction or personal assistance	Dependence (0 points) WITH supervision, direction, personal assistance or total care
Bathing Score: _____	Bathing Score: _____	Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area or disabled extremity	Needs help with bathing more than one part of the body, getting in or out of the tub or shower. Requires total bathing.
Dressing Score: _____	Dressing Score: _____	Gets clothes from closets and drawers and puts on clothes and outer garments complete with fasteners, may need help tying shoes	Needs help with dressing self or needs to be completely dressed
Toileting Score: _____	Toileting Score: _____	Goes to toilet, gets on and off, arranges clothes, clean genital area without help.	Needs help transferring to the toilet, cleaning self or uses bedpan or commode.
Transferring Score: _____	Transferring Score: _____	Moves in and out of bed or chair unassisted. Mechanical transferring aides are acceptable.	Needs help in moving from bed to chair or required a complete transfer.
Continence Score: _____	Continence Score: _____	Exercises complete self-control over urination and defecation	Is partially or totally incontinent of bowel or bladder
Feeding Score: _____	Feeding Score: _____	Gets food from plate into mouth without help. Preparation of food may be done by another person	Needs partial or total help with feeding or requires parenteral feeding.
Total Score: _____	Total Score: _____		

Participant ID Number:

Mini-Nutritional Assessment – Short Form

MNA-SF – to be calculated by a nurse in consultation with the PI

MNA-SF

T1MNA_SCORE

Data Entry Code	Question	Possible results	Patients Score
T1MNA_A	Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?	Severe decrease in food intake Moderate decrease in food intake No decrease in food intake	
T1MNA_B	Weight loss during the last 3 months	Weight loss greater than 3kg (6.6lbs) Does not know Weight loss between 1 and 3kg (2.2 and 6.6lbs) No weight loss	
T1MNA_C	Mobility	Bed or chair bound Able to get out of bed/chair but does not go out Goes out	
T1MNA_D	Has suffered psychological stress or acute disease in the past 3 months?	Yes No	
T1MNA_E	Neuropsychological problems	Severe dementia or depression Mild dementia No psychological problems	
T1MNA_F	Body Mass Index (BMI) (weight in kg) / (height in m2)	BMI < 19 BMI 19 <21 BMI 21 < 23 BMI >23	
T1MNA_G	Calf circumference (CC) in cm	CC <31 CC >31	
T1MNA_SCORE	12-14 points: Normal nutritional status 8-11 points: At risk of malnutrition 0-7 points: Malnourished		Total MNA Score: _____

ADMISSION – DENTAL EXAMINATION			
Chief dental complaint	T1DENTCC	E/O Examination	T1DENTEO
Oral Mucosa		Prosthetic Status	
Condition	T1OMCOND	Maxilla	T1PROSMAX
Location	T1OMLOC	Mandible	T1PROSMAND
Photographs	T1OMPHOT	Debris index	T1DEBRIS
Diagram	T1OMDIAG	Calculus index	T1CALC
Dental referral required	T1REFREQ	Oral hygiene index	T1OHI
Reason for referral	T1REFREASON	Who is responsible for your daily oral hygiene homecare?	T1OHI_RESP
		Description of who is responsible for OH	T1OHI_RESPDES

Dentition T1DENTCOND

Crown	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
Root																
Crown	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
Root																

Debris Index – to establish the number to enter above

Sextant	Right molar		Anterior		Left molar		Total	
Surface	Bu	Li	La	Li	Bu	Li	Bu	Li
Upper								
Lower								

Calculus Index – to establish the number to enter above

Sextant	Right molar		Anterior		Left molar		Total	
Surface	Bu	Li	La	Li	Bu	Li	Bu	Li
Upper								
Lower								

Basic Periodontal Examination - T1BPE

Sextant	Right molar	Anterior	Left molar
Upper			
Lower			

Hospital Associated Infections

HAIs – to be taken from medical record	
Urinary tract infection	T1HAI_1
Surgical site infection	T1HAI_2
Bloodstream infection	T1HAI_3
Pneumonia	T1HAI_4
Bone and joint infection	T1HAI_5
Central nervous system infection	T1HAI_6
Cardiovascular system infection	T1HAI_7
Ear, nose, throat, or mouth infection	T1HAI_8
Gastrointestinal system infection	T1HAI_9
Lower respiratory tract infection, other than pneumonia	T1HAI_10
Reproductive tract infection	T1HAI_11
Skin and soft tissue infection	T1HAI_12
Systemic infection	T1HAI_13

In-hospital Mortality (Inhosp_Mort)

Reason for death

APPENDIX 3. THE RETROSPECTIVE AUDIT PROTOCOL

Dental department utilisation by geriatricians at the TQEH

Project summary

An oral health study was conducted at TQEH from September 2013 – September 2014. It was suggested by both the dentist and geriatricians that dental referrals increased during the course of the study. The purpose of this project is to determine whether referrals to the dental unit increased due to the presence of dental personnel on the ward.

This project is a review of the electronic medical records of geriatric patients admitted to TQEH. To adequately assess the change in clinical practice the data collection period is 01.01.2011 through until the 31.12.2016.

Research question

The research question: Did referrals to the dental unit increase as a result of a regular dental hygienist working in the Geriatric Evaluation and Management Unit (GEMU)?

In addition to answering this question we aim to describe the characteristics of the people referred to the dental service in terms of medical complexity, polypharmacy and number of medical comorbidities.

Methods

Patient medical record numbers, name and admission dates will be sourced from the OACIS electronic patient record program and TQEH neck of femur (NOF) fracture databases. The OACIS electronic medical record manager will provide the research team with the list of patients admitted to the geriatric and fracture wards during the study time period. Dr. Pazhvoor Shibu maintains the NOF database, ethical approval has previously been given for access to this database (HREC/13/TQEHLMH/208), he has now been added as an associate investigator to this protocol.

The principal investigator will have access to the full patient details. Once data collection is complete all records will be de-identified. For the purposes of analysis all members of the research team will have access to the patient information, but it will be de-identified.

The aspects of the patient's medical records outlined below will be obtained before the patient information is de-identified. Once the database is assembled the identifying features, medical record number and patient name, will be removed to enable the research team to complete the analysis.

Study variables:

- Gender
- DOB
- Age
- Postcode

- Date of admission to TQEH
- Discharge Date
- Place of residence
- Reason for admission
- Surgical procedure/ ASA-PS
- Length of stay TQEH
- Number of meds
- Number of med conditions
- Death in hospital
- Date of death
- Reason for death
- No. of inpatient visits 12 months prior to study period
- Place of discharge
- Referral to dentist
- Reason for referral
- Dental clinic /Ward
- No. of dental appts during inpatient stay

Data management and statistical analysis

Dental referral data will be presented as descriptive statistics and will be analysed using SPSS Version 21. This audit will also describe the relationship between the outcome of interest, referral to the dentist, and baseline health measures including number of medications and medical conditions. These correlations between the outcomes and baseline measures will be measured using Pearson's chi-squared tests where the data is numerical and with one-way ANOVAS where the data is categorical.

Population

Approximately 700 geriatric patients were admitted to TQEH during the two-year study period. The population being investigated is elderly and generally very unwell. Many of the patients have died in hospital or will have moved into a residential aged care since discharge from the hospital. There is no need to be in verbal or physical contact with patients as we are specifically interested in the number of patients referred to the dental service.

Timeframe

Data collection will take place between April 2017 and January 2018. It is estimated that analysis and publication of results will be completed by December 2018.

Expected outcomes

We expect to find that there was an increase during the study period and hope that this has been maintained following the completion of the ward study.

It is hoped that this project will result in the inclusion of dental personnel in the multidisciplinary team that manages geriatric patients within the TQEH.

Dissemination of results

The results of this investigation will be published in an appropriate, peer-reviewed journal.

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APPENDIX 4. AUSTRALIAN ARTHROPLASTY SOCIETY STATEMENT ON THE USE OF PROPHYLACTIC ANTIBIOTICS FOR DENTAL PROCEDURES

Sourced: https://www.aoa.org.au/about-aoa/subspecialties/arthroplasty (no longer available without a membership login)

Australian Arthroplasty Society Position Statement on the use of prophylactic antibiotics for dental procedures in patients with prosthetic joints.

October 2016

The use of prophylactic antibiotics in patients with joint replacements undergoing dental procedures is controversial.

Several schools of thought exist:

- Some surgeons recommend the routine use of prophylactic antibiotics as there are rare cases where a patient presents with a septic prosthesis and an oral organism is identified. They point to the evidence that brushing teeth and dental instrumentation can cause a bacteraemia. It is felt that the risk posed by a dose of oral antibiotics is low and therefore they should always be given when a patient with a prosthesis has a dental procedure.

- An alternate viewpoint is that antibiotics should not be given at all as the risk of developing sepsis from a dental procedure is extremely low and that the evidence supporting the use of prophylactic antibiotics is lacking. Furthermore such antibiotic administration may contribute to bacterial antibiotic resistance and the risk of anaphylaxis from the antibiotic administration is higher than the risk of prosthetic infection.

- The middle ground is to give antibiotics when dental procedures are performed in the period immediately after prosthesis implantation. This is based on the theory that there is a high-risk period in a freshly implanted prosthesis when the prosthetic bone interface is maturing. This period is variously defined as between 3 and 12 months post surgery.

- It has been suggested that antibiotics might only be needed in “higher risk” situations such as major dental procedures (an extraction or a root canal), in the immunocompromised host or in those with poor oral hygiene.

The American Academy of Orthopaedic Surgeons (AAOS) and the American Dental Association (ADA) released a combined Clinical Practice Guideline in 2013 following an extensive review of the available literature. They concluded that there is a lack of evidence that a bacteraemia produced from dental treatment is linked to deep prosthetic infection and there is a lack of evidence that the use of antibiotics prevents the development of deep prosthetic infection.

The AAOS-ADA produced three recommendations and the level of supporting evidence was stated.

1. The practitioner considers changing the longstanding practice of prescribing prophylactic antibiotics for patients who undergo dental procedures. *(There is Limited evidence to support this practice)*
2. No conclusion can be drawn for or against the use of topical antibiotics for patients who undergo dental procedures. *(Inconclusive evidence)*
3. Patients should maintain good oral health *(Consensus)*

RECOMMENDATION
The Australian Arthroplasty Society agrees with this analysis and now recommends no routine antibiotic prophylaxis be give to patients with joint prostheses undergoing dental procedures.

In the immunocompromised patient or those with poor oral hygiene the surgeon is recommended to discuss the risk and benefits with his or her individual patient.

This is general advice and consideration should be given to individual patient circumstances.

References

1. The American Academy of Orthopaedic Surgeons and the American Dental Association clinical practice guideline on the prevention of orthopaedic implant infection in patients undergoing dental procedures. Rethman MP et al. J Bone Joint Surg Am. 2013 Apr 17;95(8):745-7

2. Prevention of Orthopaedic Implant Infection in Patients Undergoing Dental Procedures. Watters W et al. J Am Acad Orthop Surg. 2013 Mar;21(3):180-9

APPENDIX 5. PHD TRACK RECORD

Publications

McNally CM, Visvanathan R, Liberali S, Adams RJ. Antibiotic prophylaxis for dental treatment after prosthetic joint replacement: exploring the orthopaedic surgeon's opinion. Arthroplasty Today. 2016; 2(3): 123–126.

McNally CM and Liberali S. Oral health: an important consideration in patient care. Medical Journal of Australia. 2016; 205(7): 300.

Khow KSF, McNally C, Shibu P, Yu SCY, Visvanathan R, Chehade MJ. Getting patients back on their feet after a hip fracture. *Medicine Today*. 2016; 17(5): 30-39.

Presentations

Dignity in Care, SA Health
Dignity in Care National Conference
Eat Play Live
Adelaide, October 2015
Title: Practical Oral Hygiene for Older People

The Queen Elizabeth Hospital and The Royal Adelaide Hospital
November and December 2013
Dignity in Care
Title: Practical Oral Hygiene for Older People

Alzheimer's Australia
Adelaide, August 2016
Let's talk about - Dementia" Delirium, Depression, Deprescribing and Symptom Management
Alzheimer's Australia SA, The SA & NT Dementia Training Study Centre (SA & NT DTSC) and SA Health
Title: Oral hygiene for older people

Port Lincoln, July 2015
Mindful of Dementia
Alzheimer's Australia SA, The SA & NT Dementia Training Study Centre (SA & NT DTSC) and SA Health
Title: Practical Oral Hygiene for Older People

South Australian Dental Service
August 2015
Special Needs Unit
Title: OHNOFF Study Presentation Update

The Queen Elizabeth Hospital
November and December 2015
Acute Medical Unit
Title: Practical Oral Hygiene for Older People

August 2014
Speech Pathologists
Title: The oral health of hospitalised elderly

July 2014
Aged and Extended Care team presentation
Title: The oral health of hospitalised elderly

Nursing Grand Rounds
Title: The importance of oral health for the elderly

The Adelaide Geriatrics Training and Research with Aged Care (G-TRAC)

September 2013

Title: The Importance of Oral Health for the Elderly: Oral Health and Health Outcomes & Oral Health Assessment Tools.

Poster Presentations

ASMR SA Annual Scientific Meeting June - 2014

Title: Investigation of the association between oral health and health outcomes in older people following a neck of femur fracture. An exploratory study.

12th National Conference of Emerging Researchers in Ageing – Sydney 2013

Title: Investigation of the association between oral health and health outcomes in older people following a neck of femur fracture. A pilot study.

Invited Reviewer

Gerodontology

Australian and New Zealand Journal of Oral Health Therapy